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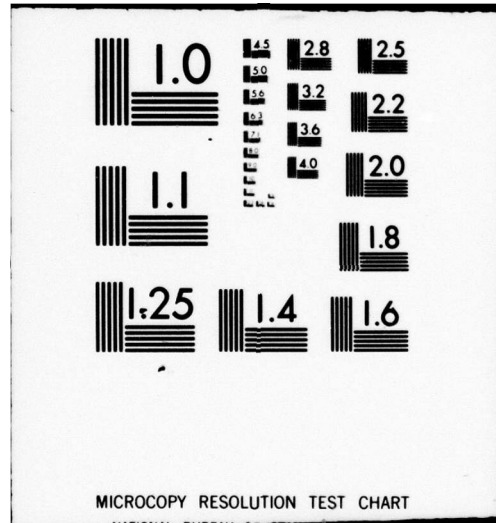
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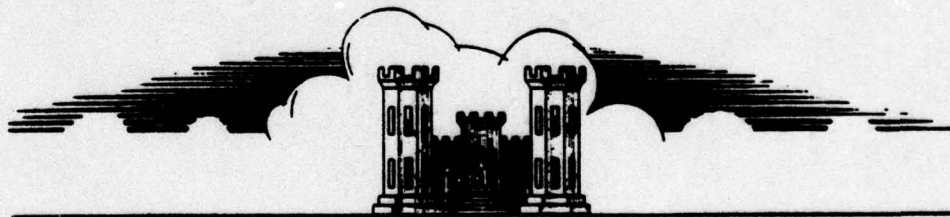
BRADFORD CITY No. 3 DAM

NDI No. PA 00025
PennDER No. 42-10

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



prepared for

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

prepared by

MICHAEL BAKER, JR., INC.
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February 1979

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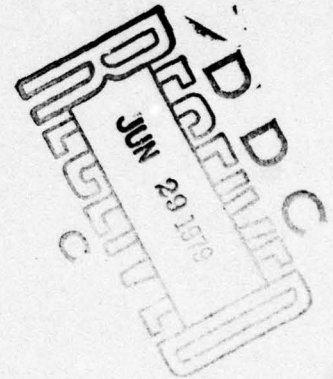
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OHIO RIVER BASIN

BRADFORD CITY NO. 3 DAM
MCKEAN COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI NO. PA 00025
PennDER NO. 42-10

6 National Dam Inspection Program.
Bradford City Number 3 Dam (NDI-PA-00025,
PennDER Number 42-10), Ohio River Basin,
Marilla Brook, McKean County, Pennsylvania.
Phase I Inspection Report.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



10 C.Y. / Chen

Prepared for: DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
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Date: 11 February 1979

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PREFACE

This report is prepared under guidance contained in the "Recommended Guidelines for Safety Inspection of Dams," for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Bradford City No. 3 Dam, McKean County, Pennsylvania
NDI No. PA 00025, PennDER No. 42-10
Marilla Brook
Inspected 8 and 9 November 1978

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ASSESSMENT OF
GENERAL CONDITIONS

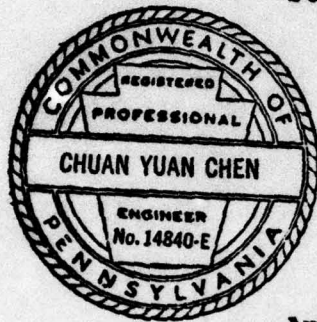
Bradford City No. 3 Dam is a diaphragm earthfill embankment dam approximately 47 feet high and 770 feet long. The dam is owned and operated by the Bradford City Water Authority.

The visual inspections and review of engineering data, performed in November 1978 through February 1979, indicate no serious deficiencies in the embankment requiring emergency attention. The dam was found to be in good overall condition at the time of inspection. However, the inspection revealed certain items of maintenance and rehabilitation necessary for the dam, including repair of the animal burrows, removal of the vegetation and debris in the downstream channel, repair of the upstream slope riprap, repointing of spillway structure joints, placement of adequate erosion protection in the downstream channel, and development of a plan for rapid closure of the upstream ends of the outlet pipe and water supply pipe in an emergency. Additionally, the two seepage areas should be examined periodically in the future, and a record should be kept of their condition.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District of the U.S. Army Corps of Engineers for Phase I Inspection Reports, revealed that the spillway will not pass the Probable Maximum Flood (PMF) without overtopping the dam. The spillway is considered "inadequate" because the analysis indicated the spillway will pass a maximum of 45 percent of - - - - -

the PMF before overtopping the dam, and failure of the dam is not likely to occur under 50 percent PMF conditions. ← Therefore, the owner should immediately undertake a detailed engineering study to evaluate the spillway capacity and to develop recommendations for remedial measures to reduce the overtopping potential of the embankment. The owner should also develop emergency operation and evacuation procedures.

Submitted by:



MICHAEL BAKER, JR., INC.

C. Y. Chen

C. Y. Chen, Ph.D., P.E.
Engineering Manager-Geotechnical

Date: 16 February 1979

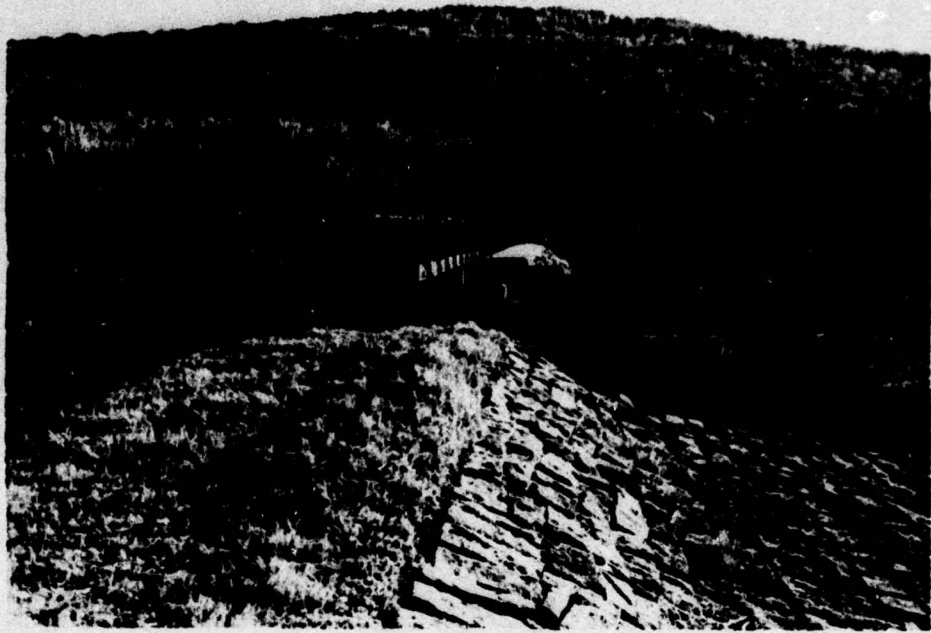
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

G. K. Withers
G. K. Withers
Colonel, Corps of Engineers
District Engineer

Date: 15 Mar 79

BRADFORD CITY No. 3 DAM



Overall View of Upstream Area



Overall View of Downstream Area

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BRADFORD CITY NO. 3 DAM
NDI NO. PA 00025, PennDER No. 42-10

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority - The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.
- b. Purpose of Inspection - The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances -  Bradford City No. 3 Dam consists of a diaphragm earthfill embankment approximately 47 feet high and 770 feet long. A core wall consisting of mortar and sandstone blocks was constructed in the center of the embankment. The core wall extends 25 feet into each hillside and approximately 9 feet below the original ground surface at the deepest point in the center of the valley. The core wall is 2 feet wide at the top and 6 feet wide at the base. The core wall rests on an 18-inch thick, 8-foot wide, concrete foundation. The concrete foundation rests on in situ soil. The crest width of the embankment is 12 feet, and the core wall is located 7 feet below the center of the crest. The upstream slope to El. 1728 feet is paved with sandstone blocks laid on a 12-inch thick, crushed stone base. The remaining upstream slope to the toe is paved with cobbles. The upstream slope is 2.5 horizontal to 1 vertical (2.5H:1V) while the downstream slope is 2H:1V. A trapezoid (at the widest dam section), 56 feet wide at the base and 12 feet wide at the crest constructed of "select material," is shown on the original design drawings as the central zone of the embankment. The outer portion of the upstream embankment is another zone of "select material" and is shown as a 20-foot wide section at the toe tapering to the apex at approximate El. 1735 feet.

[CONT'D
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The center of the ungated spillway is located approximately 90 feet right of the left abutment. Sandstone blocks form the abutments (training walls) of the spillway. A 3-foot wide, steel walkway located directly above and parallel to the spillway crest is supported by a 1-foot wide by 3-foot long pier at the center of the spillway crest. The spillway consists of a 12H:1V approach channel, a 3.5-foot long crest (in the direction of flow), and a 5H:1V sandstone-block-lined, discharge channel which is 33 feet long. From this point, the discharge channel is stepped down to a timber planking overflow into the concrete-rubble-lined downstream channel. Additional details are shown on Plate 7.

Two 16-inch outlet pipes are located near the center of the embankment. One pipe serves as a water supply line and the other is outletted downstream from the dam. The intake structure is located at the toe of the upstream slope. Details of the outlet pipes and intake structure are shown on Plates 4 and 6.

- b. Location - Bradford City No. 3 Dam is located in Bradford Township, McKean County, Pennsylvania approximately 5 miles west of Bradford, Pennsylvania. Located adjacent to the north shore of the reservoir and left abutment area of the dam is Pennsylvania Route 346. The dam is located on Marilla Brook approximately 5 miles upstream of the City of Bradford. Gilbert Run joins Marilla Brook approximately 1 mile downstream from the dam. An additional 2.5 miles downstream, Marilla Brook joins the West Branch of Tunungwant (Tuna) Creek. Tuna Creek then flows through the center of the City of Bradford.
- c. Size Classification - The maximum height of the dam is 47 feet. The reservoir volume to the top of the dam at El. 1750.8 feet is 502 acre-feet. Therefore, the dam is in the "Intermediate" size category.
- d. Hazard Classification - More than a few lives would likely be lost in the event of a failure of the dam; therefore, this dam is considered in the "High" hazard category.

- e. Ownership - The dam is owned by the Bradford City Water Authority, 24 Kennedy Street, Bradford, Pennsylvania 16701. The present chairman of the water authority is Mr. O. C. Knott. The present superintendent of the water authority is Mr. Pat A. Nuzzo.
- f. Purpose of the Dam - The dam is used for water supply storage.
- g. Design and Construction History - The dam was constructed in 1898 under the supervision of Mr. Charles A. Hague, who also prepared the plans. Mr. W. M. Hanley of Bradford, Pennsylvania was the contractor.

A record of borings, made under the direction of Elbert Nostrand, Engineer and Surveyor of New York, New York, was prepared in August 1898 and is presented as Plate 8 of this report. Thirteen (13) borings were performed on 50-foot centers along the centerline of the dam, with an additional three borings performed approximately 400 feet upstream from the centerline. No record was readily available relating the assumed datum for the soil borings to the datum used for the original design drawings. However, it can be determined that the foundation of the dam and core wall was founded on soil.

No information concerning the method of construction or changes from the design drawings during construction was available. Information contained in the 11 August 1915 "Report Upon the Number 3 Dam of the Bradford Municipal Water Works," which was prepared by the Water Supply Commission of Pennsylvania [predecessor to the Pennsylvania Department of Environmental Resources (PennDER)], indicates that the borrow area for the embankment was at the upper end of the reservoir. Other information contained in the report describes the embankment, core wall, spillway, and outlets. However, the descriptions contained in the report were apparently derived from the original design drawings and may not represent "as built" conditions.

- h. Normal Operational Procedures - The reservoir is maintained at approximately the same level year round. Personnel of the water authority visit the gate house daily to regulate and maintain the chlorine for water supply purposes. Typically, the dam is examined twice a week to determine the extent of routine maintenance required.

1.3 PERTINENT DATA

- a. Drainage Area - The drainage area of Bradford City No. 3 Reservoir is 4.8 square miles.
- b. Discharge at Dam Site - The maximum flow at the dam site over the spillway is unknown. The ungated spillway capacity at minimum top of dam elevation is approximately 3200 c.f.s.
- c. Elevation [feet above Mean Sea Level (M.S.L.)] -
- | | |
|----------------------------------|--------|
| Design Top of Dam - | 1750.0 |
| Minimum Top of Dam - | 1750.4 |
| Average Top of Dam - | 1750.8 |
| Maximum Pool - | 1750.4 |
| Normal Pool - | 1744.0 |
| Streambed at Centerline of Dam - | 1704.0 |
| Maximum Tailwater - | N.A. |
- d. Reservoir (feet) -
- | | |
|--------------------------|------|
| Length of Maximum Pool - | 1700 |
| Length of Normal Pool - | 1500 |
- e. Storage (acre-feet) -
- | | |
|--------------------------------------|-----|
| At Spillway Crest (El. 1744.0 ft.) - | 368 |
| At Top of Dam (El. 1750.8 ft.) - | 502 |
- f. Reservoir Surface (acres) -
- | | |
|-----------------------------------|------|
| Spillway Crest (El. 1744.0 ft.) - | 18.2 |
| Top of Dam (El. 1750.4 ft.) - | N.A. |
- g. Dam -
- | | |
|--------------------------|---|
| Type - | Earthfill |
| Length (feet) - | 770 |
| Height (feet) - | 47 |
| Top Width (feet) - | 12 |
| Side Slopes - Upstream - | 2.5H:1V |
| Downstream - | 2H:1V |
| Zoning - | The original design drawings indicate a central zone, 30 feet thick at the base of the dam on the upstream side of the stone-masonry core wall and 20 feet thick at the base of the dam on the downstream side of the stone-masonry core wall. This zone is described as "select material" on the original design drawings. |

Impervious Core - Masonry-stone core wall consisting of sandstone blocks laid with portland cement mortar. Maximum thickness is 6 feet at the base and 2 feet minimum thickness at the top of the core wall.

Cutoff - At the deepest section of the embankment the stone-masonry core wall was constructed 9 feet below the original ground surface.

h. Diversion and Regulating Tunnel - None

i. Spillway -

Type -	Overflow
Width of Weir (feet) -	58.6
Crest Elevation (feet M.S.L.) -	1744.0
Gates -	None
Width of Upstream Channel (feet) -	59.3
Width of Downstream Channel (feet) -	59.8

j. Regulating Outlets - A 16-inch cast-iron pipe is located approximately 350 feet right of the left abutment. A control valve is located in the gate house of the downstream toe of the embankment.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Review of information included:

- 1) PennDER file for Bradford City No. 3 Dam:
 - a) "Report Upon the Number 3 Dam of the Bradford Municipal Water Works" prepared by the Water Supply Commission of Pennsylvania (predecessor of PennDER) and dated 11 August 1915.
 - b) Design drawings for installation of flashboards on the spillway crest.
 - c) Various inspection reports by state personnel.
 - d) Various correspondence.
 - e) Specifications for the enlargement of the spillway (1923).
 - f) Various photographs as a result of the inspections performed.
 - g) Permit application and permit for the temporary installation of flashboards on the spillway crest.
- 2) Original drawings, with some modifications, obtained from Mr. Pat Nuzzo, Superintendent of Bradford City Water Authority.

The last inspection of the dam was performed on 15 September 1977 by Mr. Walter Leidig of the Dam Safety Section of PennDER. Mr. Leidig noted in his report, "The riprap on the upstream embankment slope should be reworked and missing stone replaced. Minor seepage observed at the toe. Vegetation is causing seepage under the right spillway wall." Mr. Leidig recommended repair of the riprap, removal of the vegetation, and plugging the leaks under the right spillway wall.

2.2 CONSTRUCTION

Bradford City No. 3 Dam was constructed in 1898 under the supervision of Mr. Charles A. Hague, who also prepared the plans. Mr. W. M. Hanley, of Bradford, Pennsylvania was the contractor. Because of the age of the dam and because detailed information was not recorded at that time, no information concerning the method of construction or changes from the design drawings during construction was available.

2.3 OPERATION

Operation records are not recorded for Bradford City No. 3 Dam and Reservoir. The Bradford City Water Authority is responsible for maintenance and operation of the dam and appurtenant structures.

2.4 EVALUATION

- a. Availability - Much of the information reviewed is readily available in PennDER's Bradford City No. 3 Dam file. Additional information helpful in assessing the safety and potential hazard was requested from the owner of the dam. It is very doubtful that any additional information exists concerning this dam other than in PennDER's and the owner's files.
- b. Adequacy - The readily available information and the results of the field inspection are considered adequate for a Phase I Investigation of the dam.
- c. Validity - Based upon the field observation there is no cause to doubt the validity of the information available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

- a. General - The inspection was performed on 8 and 9 November 1978. No unusual weather conditions were experienced and the lake was at normal pool. The dam and appurtenant structures were found, in general, to be in good overall condition at the time of inspection. The problems noted are considered minor and do not require immediate remedial treatment. Noteworthy deficiencies are described briefly in the following paragraphs. The complete visual inspection check list and field sketch are presented in Appendix A.
- b. Dam - Seepage was observed exiting from the toe of the slope approximately 575 feet right of the left abutment. No migration of fine materials (piping) was observed during the inspection. The area in plan was approximately 1 square foot. The rate of flow is considered minor and was estimated to be less than 1 g.p.d. This area of seepage has been noted in various inspections performed by PennDER personnel since 1922. Another seepage area was observed to the right of the gate house (approximately 350 feet right of the left abutment) at the toe of the embankment. This area did not have any discernible flow, but it appeared to be moist all the time. This area has also been noted during previous inspections by PennDER personnel.

Several rodent/groundhog/animal burrows were observed in the downstream slope of the embankment. The locations of these holes are shown on the field sketch in Appendix A.

The sandstone block riprap on the upstream slope of the embankment is missing at several locations (typically just one block) and should be replaced. At other locations, the riprap has "popped out" such that the riprap is not lying flat against the slope as originally constructed.

The embankment is covered with well-maintained grass and, overall, is in very good condition. No serious deficiencies in the crest, slopes or toe of the embankment were observed.

- c. Appurtenant Structures - No unusual conditions were observed at the outlet pipe. The valve for the outlet pipe is located at the toe of the embankment in the gate house. The valve is typically opened twice a year to insure proper operation.

The spillway structure was found to be in good overall condition. Some minor debris and vegetation was observed in the discharge channel. Some of the joints in the masonry block training walls need repointing. The steel walkway and bridge pier over the spillway were in good condition.

- d. Reservoir Area - The area surrounding the reservoir is gently to moderately sloping and highly forested. No problems were observed in the reservoir area.
- e. Downstream Channel - A small access road bridge is located across the downstream channel, approximately 500 feet downstream from the spillway (see Photo 4). This bridge will not constrict the flow from the spillway. Approximately 30 residences are located in the first mile downstream from the reservoir. There are several hundred homes located downstream along Marilla Brook and the West Branch of Tuna Creek. Tuna Creek then flows through the City of Bradford (1970 census approximately 13,000 people).

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures are generally discussed in paragraphs 1.2.h. and 2.3.

There are no formal written procedures for reservoir operation or emergency downstream evacuation in the event of impending catastrophe.

It is recommended that a formal emergency procedure be prepared and prominently displayed, and furnished to all personnel. This should include:

- 1) Procedures for evaluating inflow during periods of emergency operation.
- 2) Procedures for rapid drawdown of the reservoir under emergency conditions.
- 3) Who to notify, including public officials, in case evacuation from the downstream area is necessary.

In addition, the owner should assist public officials in developing an emergency evacuation plan for areas which will be affected in the event of a dam failure.

4.2 MAINTENANCE OF DAM

The Bradford City Water Authority is responsible for maintenance of the dam. The maintenance procedures of the water authority are generally considered adequate; however, a rodent control program should be implemented.

4.3 MAINTENANCE OF OPERATING FACILITIES

The Bradford City Water Authority is responsible for maintenance of the operating facilities. Typically, the outlet pipe valve is opened twice a year to insure operational adequacy. Presumably, proper maintenance would be performed at this time to insure continued operation in the future.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system or procedure in the event of a dam failure. An emergency warning procedure should be developed as recommended in paragraph 4.1.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The maintenance procedures for Bradford City No. 3 Dam are adequate except for the deficiencies noted. The operational functions of the dam are considered adequate. Emergency procedures should be developed as recommended in paragraph 4.1.

No closure is presently provided on the upstream side of the embankment for the outlet pipe and water supply pipe. If either pipe should develop a leak within the embankment, the potential for failure of the dam would be high. Therefore, a plan should be developed for closing the upstream ends of the pipes in the event of an emergency and for periodic inspection of the pipes.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data - There were no design calculations available for review and evaluation. The first check of spillway capacity performed by the Water Supply Commission of Pennsylvania in 1915 indicated the spillway capacity was 1316 c.f.s. According to the report, the spillway would not pass the Probable Maximum Flood (PMF). They recommended revising the spillway to achieve a capacity of not less than 1700 c.f.s. The embankment top of dam was later (1923) increased by 3 feet, and the spillway wing walls were correspondingly increased to provide additional discharge capacity before overtopping would occur.
- b. Experience Data - Based upon a report of the 17-20 July 1942 flood, the spillway peak discharge was 640 c.f.s. No other data were available except for occasional references of the reservoir level noted on the inspection report forms of the Water and Power Resources Board (a predecessor of PennDER).
- c. Visual Observations - Except for minor amounts of debris and vegetation in the downstream channel, no deficiencies were observed in the spillway or spillway channels. Frequent routine maintenance should remove debris from the spillway and spillway channels. The vegetation in the channel should be removed.
- d. Overtopping Potential - The Bradford City No. 3 Dam is classified as a "High" hazard-"Intermediate" size dam requiring evaluation for a spillway design flood (SDF) equal to the PMF. The spillway consists of a 59.6-foot wide, rectangular shaped, approach channel and control weir. A 1-foot wide, walkway bridge pier is located at the center of the spillway crest reducing the effective width to 58.6 feet. The hydrologic and hydraulic capabilities of the reservoir and spillway were evaluated by routing the PMF through the reservoir with the aid of the U.S. Army Corps of Engineers Flood Hydrograph Package, HEC-1. The PMF and 1/2 PMF were both found to overtop the dam by depths of 1.6 and 0.5 feet, respectively. The results of this analysis indicate that the reservoir and spillway are capable of passing a flood approximately equal to 45 percent of the PMF.

- e. Spillway Adequacy - The dam, as outlined in the above analysis, would be overtopped by the 1/2 PMF. The criteria, for spillway adequacy determination, requires an estimate of the likelihood of dam failure during overtopping by 1/2 PMF conditions. Therefore, the following conditions were used as the limiting criteria which are likely to cause failure of this dam.

- 1) Depth of overtopping in excess of 1.0 foot.
- 2) Duration of overtopping in excess of 4 hours.*
- 3) Approximate maximum velocity of overtopping in excess of 4 f.p.s.*

The overtopping analysis of this dam yielded the following values.

- 1) 0.5 foot
- 2) 1.5 hours
- 3) 2.8 f.p.s.

Therefore, dam failure during the above 1/2 PMF conditions is not likely to occur and the spillway is assessed as "inadequate."

The hydrologic determinations presented in this Phase I Inspection Report are based upon the use of a Snyder's unit hydrograph developed from coefficients determined by the Baltimore District of the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variation of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed, a further refinement of these coefficients is beyond the scope of this Phase I investigation and, therefore, must be addressed by the dam owner's engineering consultant during the detailed investigation as suggested in the "Assessment of General Conditions."

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

*These parameters will vary according to cover and material conditions of the dam crest.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations - No structural inadequacies were noted during the visual inspection of the dam. The seepage areas indicated in paragraph 3.1.b. do not appear to have increased significantly from the descriptions provided by previous inspections performed by PennDER (or its predecessor) personnel. These seepage areas are not considered detrimental to the stability of the dam according to the conditions present at the time of inspection. These seepage areas should be periodically examined in the future to verify that the quantity of seepage is not increasing and transportation of fine material is not occurring. Should the extent of the seepage areas or characteristics of the seepage increase with time, the condition should be studied in detail and appropriate remedial measures taken.
- b. Design and Construction Data - Calculations of embankment slope and foundation stability were not available for review. Given the age of the structure (designed in 1898), and the state-of-the-art in geotechnical engineering and dam design at that time; it is expected that no calculations were performed. Based on the visual observations and also on empirical guidelines on stable slope inclinations given by the U.S. Bureau of Reclamation (1973) Design of Small Dams, 2nd edition, pp. 261-267; it is concluded that Bradford City No. 3 Dam could be shown to satisfy the stability requirements of the "Recommended Guidelines for Safety Inspection of Dams."
- c. Operating Records - No operational records are available for Bradford City No. 3 Dam. Operational procedures obtained by interviewing the water authority personnel do not indicate cause for concern related to the structural stability of the dam.
- d. Post-Construction Changes - The post-construction modifications made to the dam do not adversely influence the structural stability of the dam.

- e. Seismic Stability - The dam is located near the boundary between Zones 1 and 2 on the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." Both of these zones are considered to present no hazard from earthquakes provided static stability conditions are satisfied and conventional safety margins exist. As indicated in paragraph 6.1.b., Bradford City No. 3 Dam could be shown to meet the stability requirements of the "Recommended Guidelines for Safety Inspection of Dams." Therefore, further consideration of the seismic stability is not warranted for this Phase I Inspection Report.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

- a. Safety - There are no findings, as a result of this Phase I Inspection, from which a detrimental assessment of the structural stability can be rendered provided the embankment is not overtopped by flood waters. The spillway capacity was analyzed using the procedures presented in paragraphs 5.1.d. and 5.1.e. The analysis, based upon the routings, determined that the spillway will pass approximately 45 percent of the PMF before overtopping will occur. As a result of this observation and others noted in Section 5, the spillway is considered "inadequate."
- b. Adequacy of Information - The information available and the observations made during the field inspection are considered sufficient for this Phase I Inspection Report.
- c. Urgency - The owner should initiate without delay further investigation, as discussed below in paragraph 7.1.d.
- d. Necessity for Additional Data/Evaluation - The hydraulic/ hydrologic analysis performed in connection with this Phase I Inspection Report has indicated the need for additional spillway capacity. It is recommended that the owner of Bradford City No. 3 Dam immediately initiate an engineering study to further evaluate the spillway capacity and develop recommendations for remedial action as necessary.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection and review of information revealed certain items of work which should be performed immediately by the owner. These include:

- 1) The owner should initiate an engineering study to further evaluate the spillway capacity and develop recommendations for remedial action as necessary.
- 2) The removal of the vegetation and debris from the downstream channel.

- 3) Development of emergency operations procedures for the reservoir including:
 - a) Procedures for evaluating inflow during periods of emergency operation.
 - b) Procedures for rapid drawdown of the reservoir under emergency conditions.
 - c) Who to notify, including public officials, in case evacuation from the downstream area is necessary.
 - d) Provide around-the-clock surveillance of the dam and reservoir during periods of high runoff.
 - e) The installation of a reliable flood warning system for all areas downstream of the dam which would be affected in the event of the failure of the dam.

In addition, the owner should assist public officials in developing the evacuation plan for areas which will be inundated in the event of a flood or dam failure.

The inspection and review of information revealed other items of work which should be accomplished in the near future by the owner. These include:

- 1) Repair of the animal burrows in the embankment and establishment of a rodent control program.
- 2) Repointing of the joints of the sandstone block spillway structure.
- 3) Repair of the riprap on the upstream face.
- 4) Placement of riprap protection along the left bank of the downstream channel where erosion is occurring.
- 5) The periodic inspection of the seepage areas to identify a change in quantity or the exiting of muddy water from these areas and, if necessary, to assess the stability and piping potential of the dam in connection with the seepage conditions.

Additionally, the owner should develop a plan for rapid closure at the upstream ends of the outlet pipe and water supply pipe in the event of a pipe rupture and for periodic inspection.

PLATES

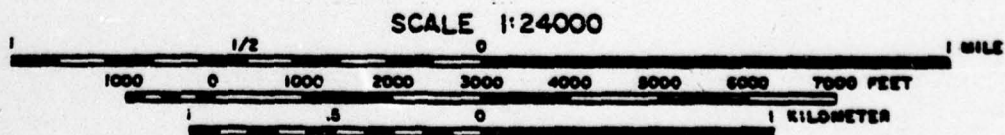
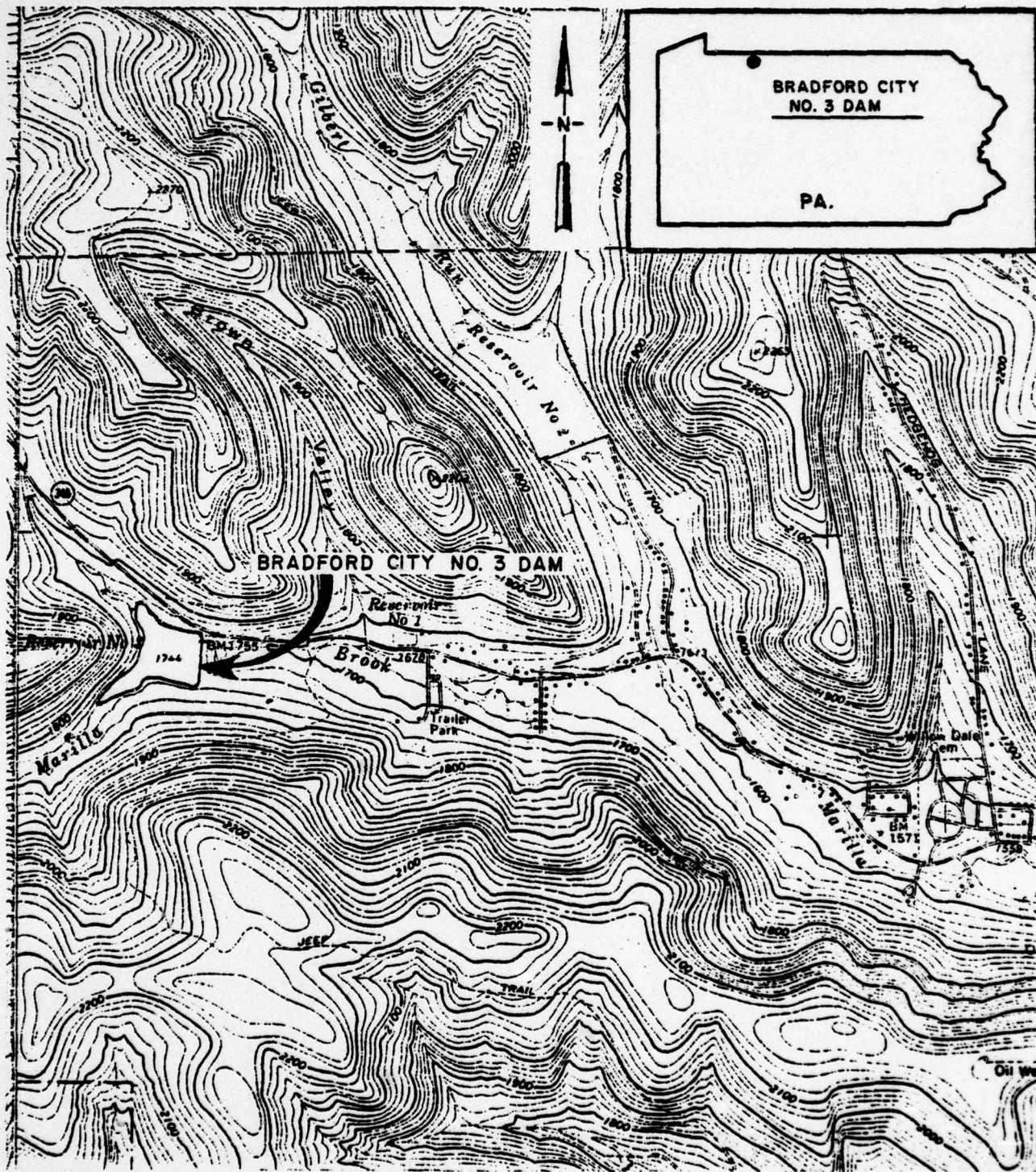


PLATE I LOCATION PLAN
BRADFORD CITY NO. 3 DAM

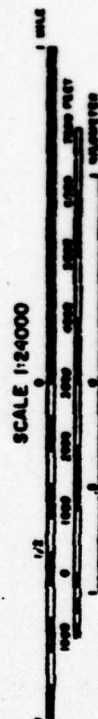
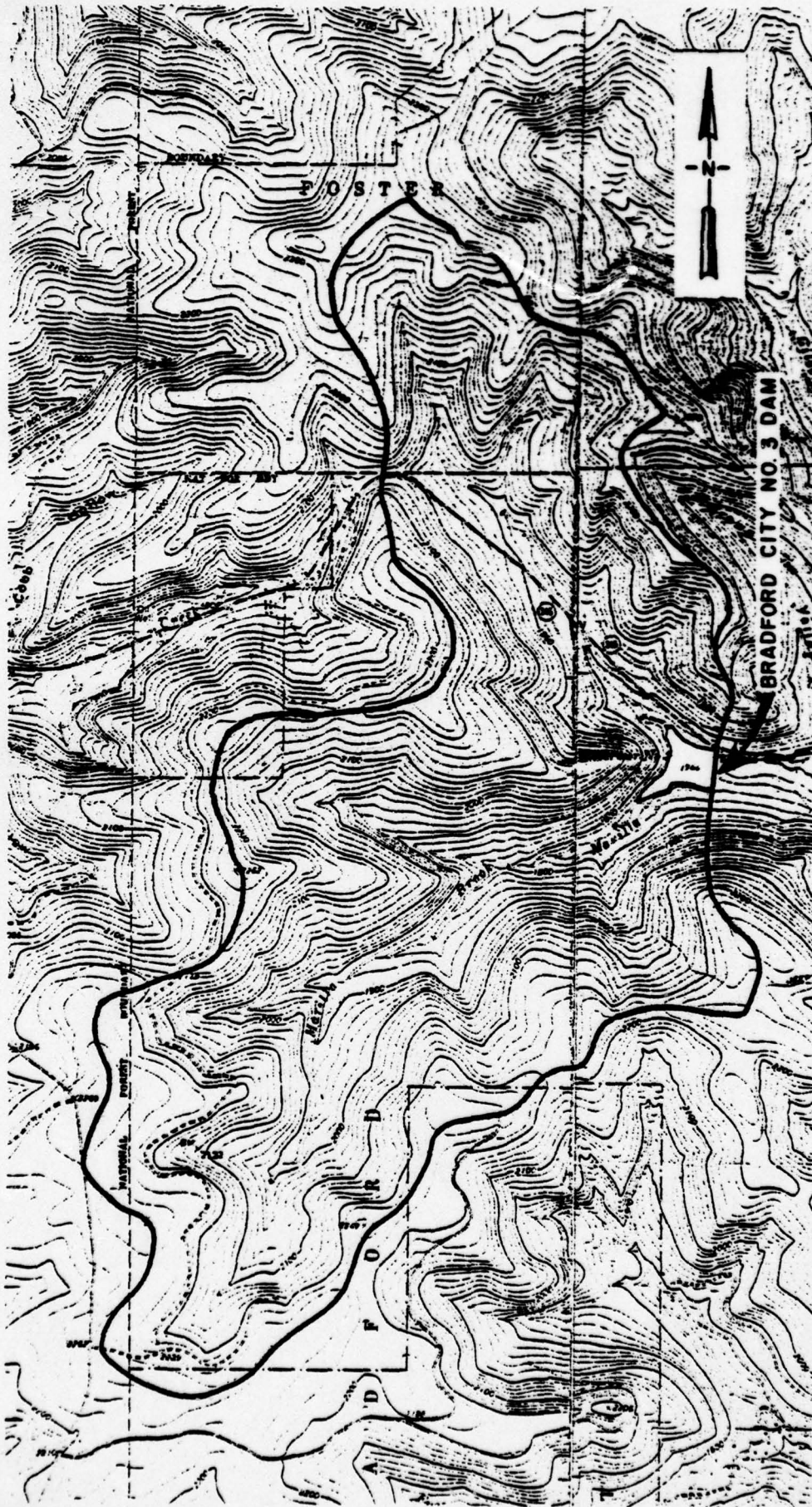
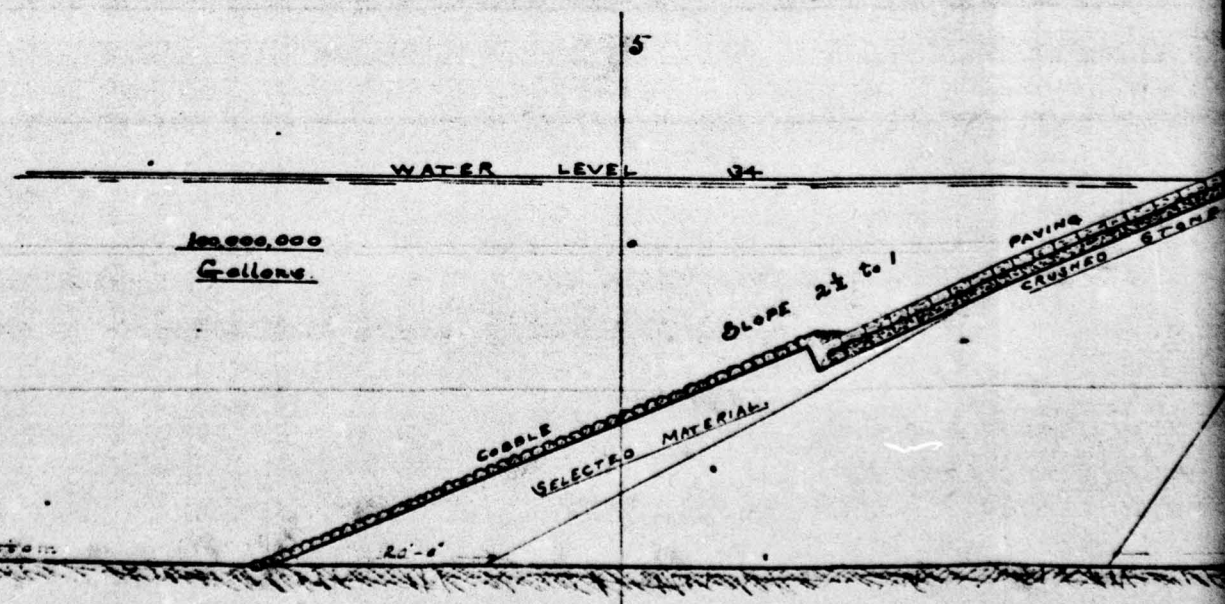
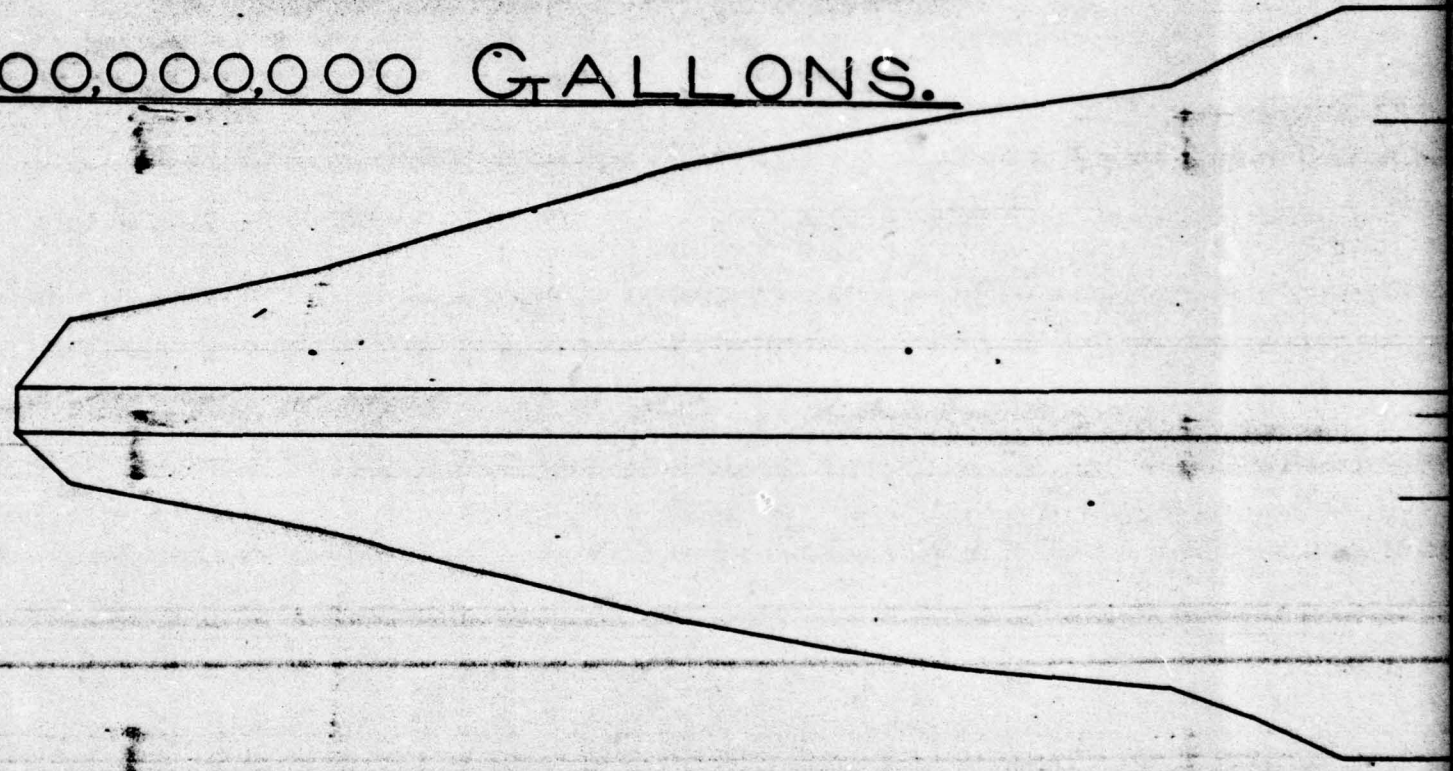


PLATE 2 WATERSHED MAP
BRADFORD CITY NO. 3 DAM



BRADFORD No. 3.

100,000,000 GALLONS.



Chara Hagan July 26 98

ELEVATION OF CORE WALL.

Scale $24' = 1"$

PLAN OF DAM.

SECTION OF DAM.

BRADF

100,000.0

DETAILS OF
OUTLET

Scale $\frac{1}{2} = 1'$

CONCRETE

33'-0"

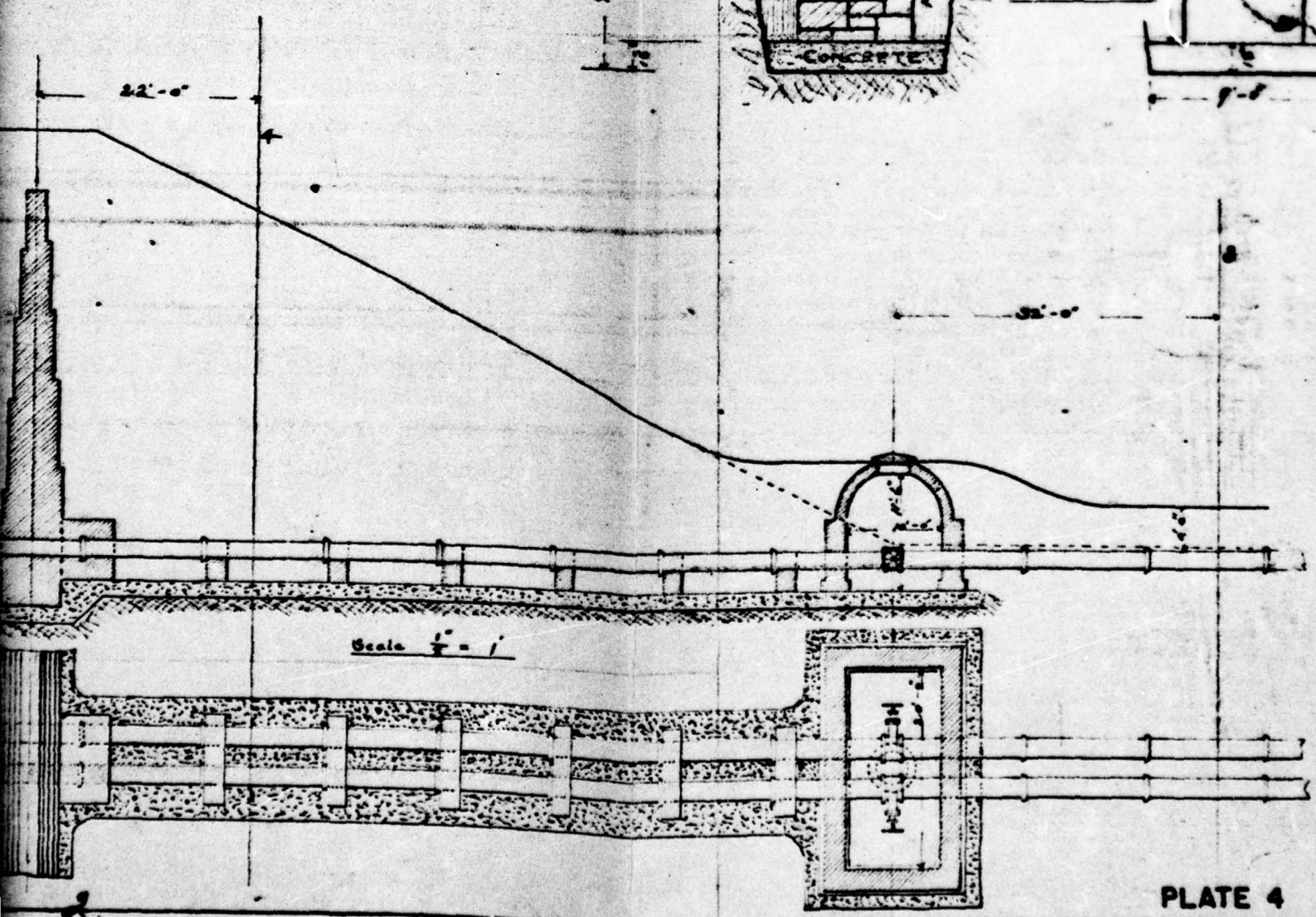
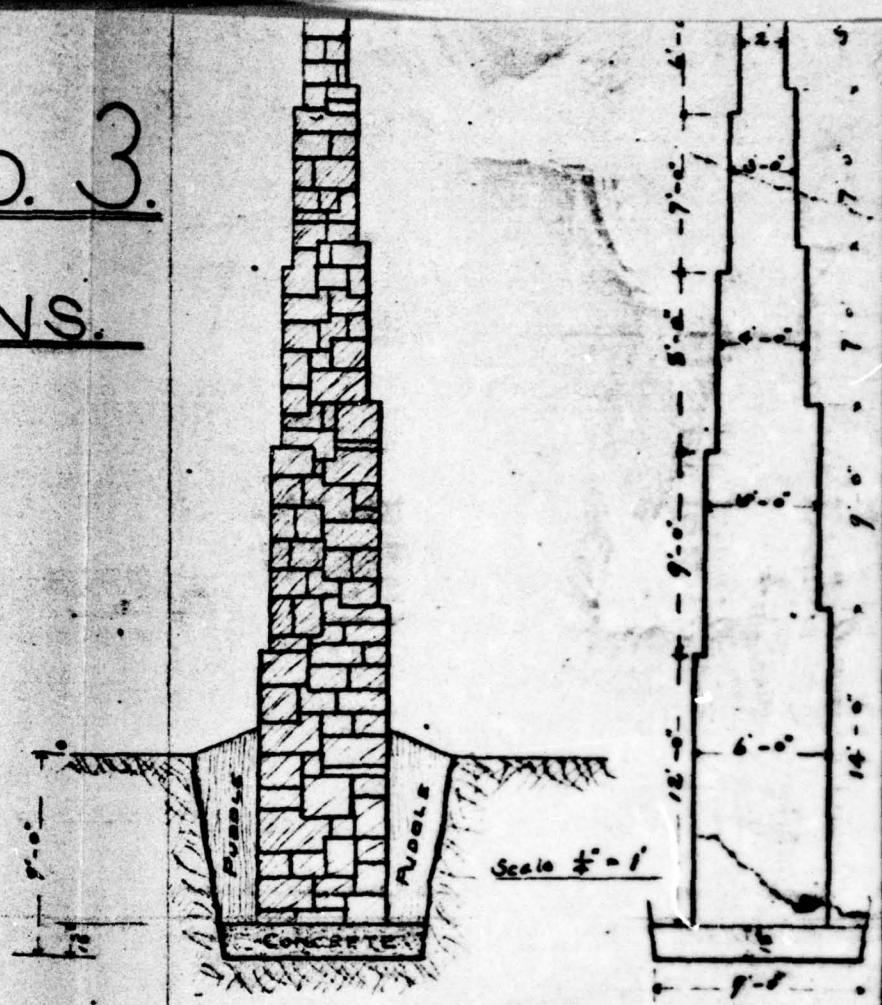
TWO 16" OUTLET PIPES.

Charlottesville Aug. 26 '18

DFORD No. 3.

00,000 GALLONS.

CORE WALL
LET PIPES.



D.

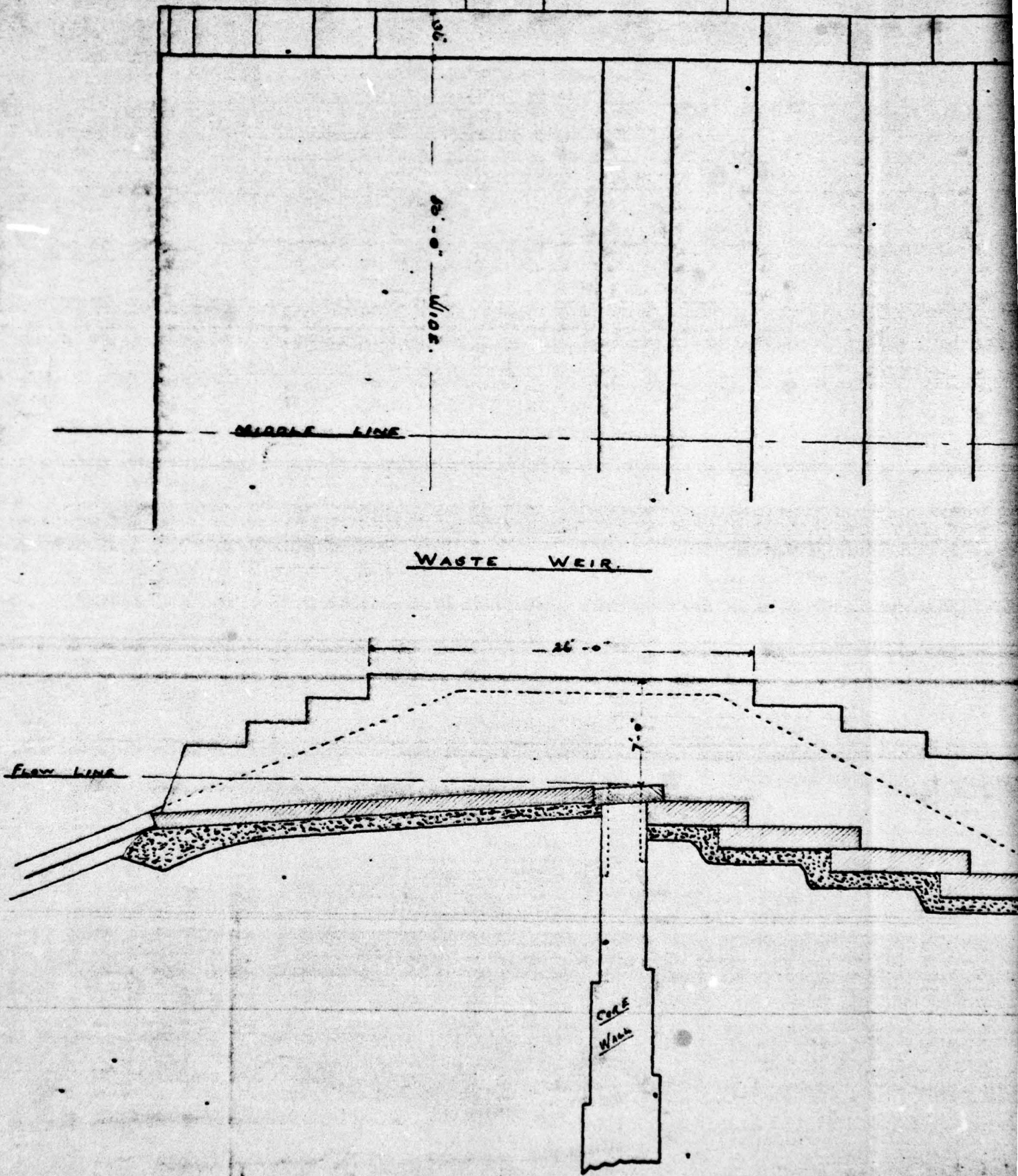
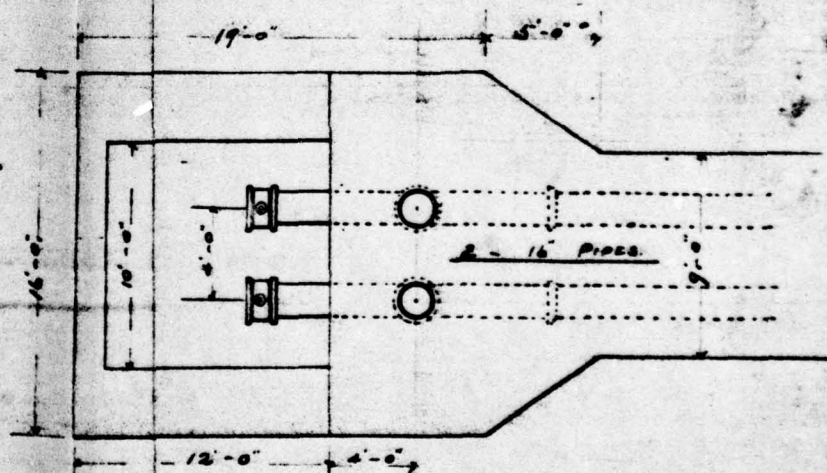
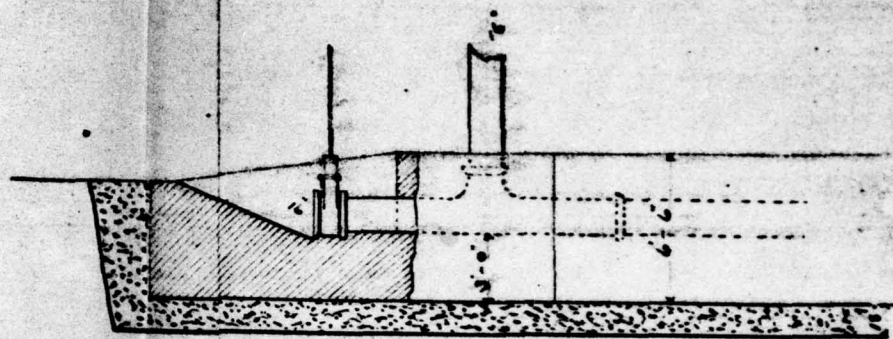


Chart House



DETAIL OF OUTLET PIPES (16)

BRADFORD No. 3.

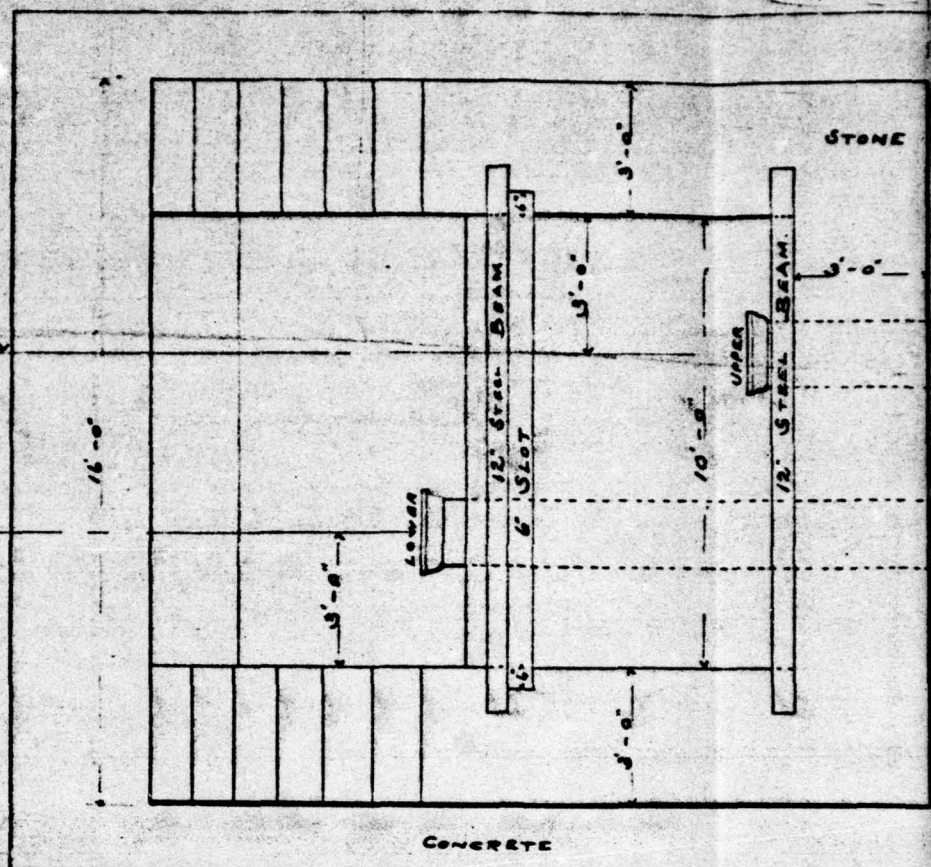
100,000,000 GALLONS.

Scale $\frac{1}{2}$ in. = 4'-0" feet

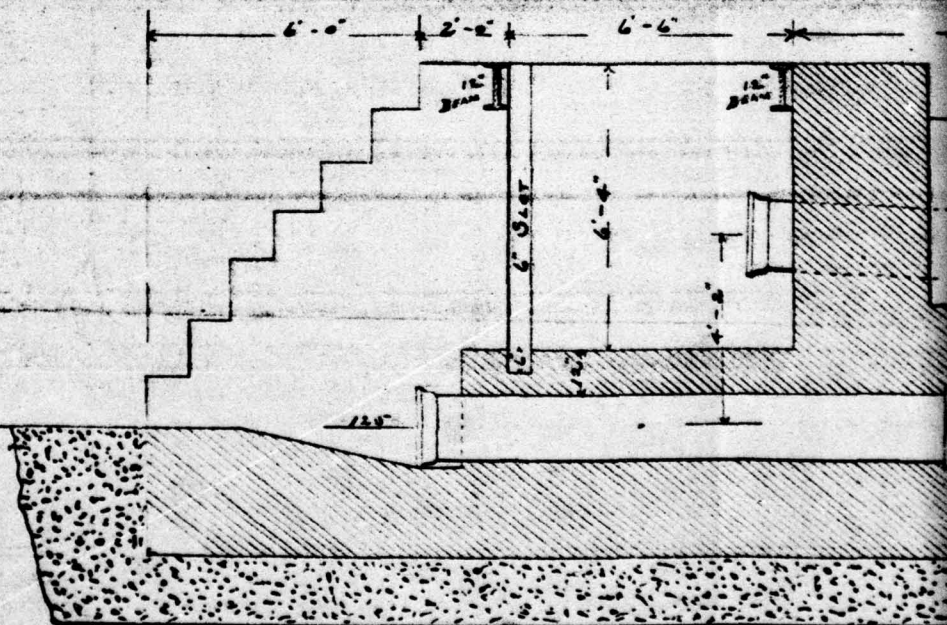
PLATE 5

Centre of upper 16" Pipe
 Centre of Masonry
 Centre of lower 16" Pipe

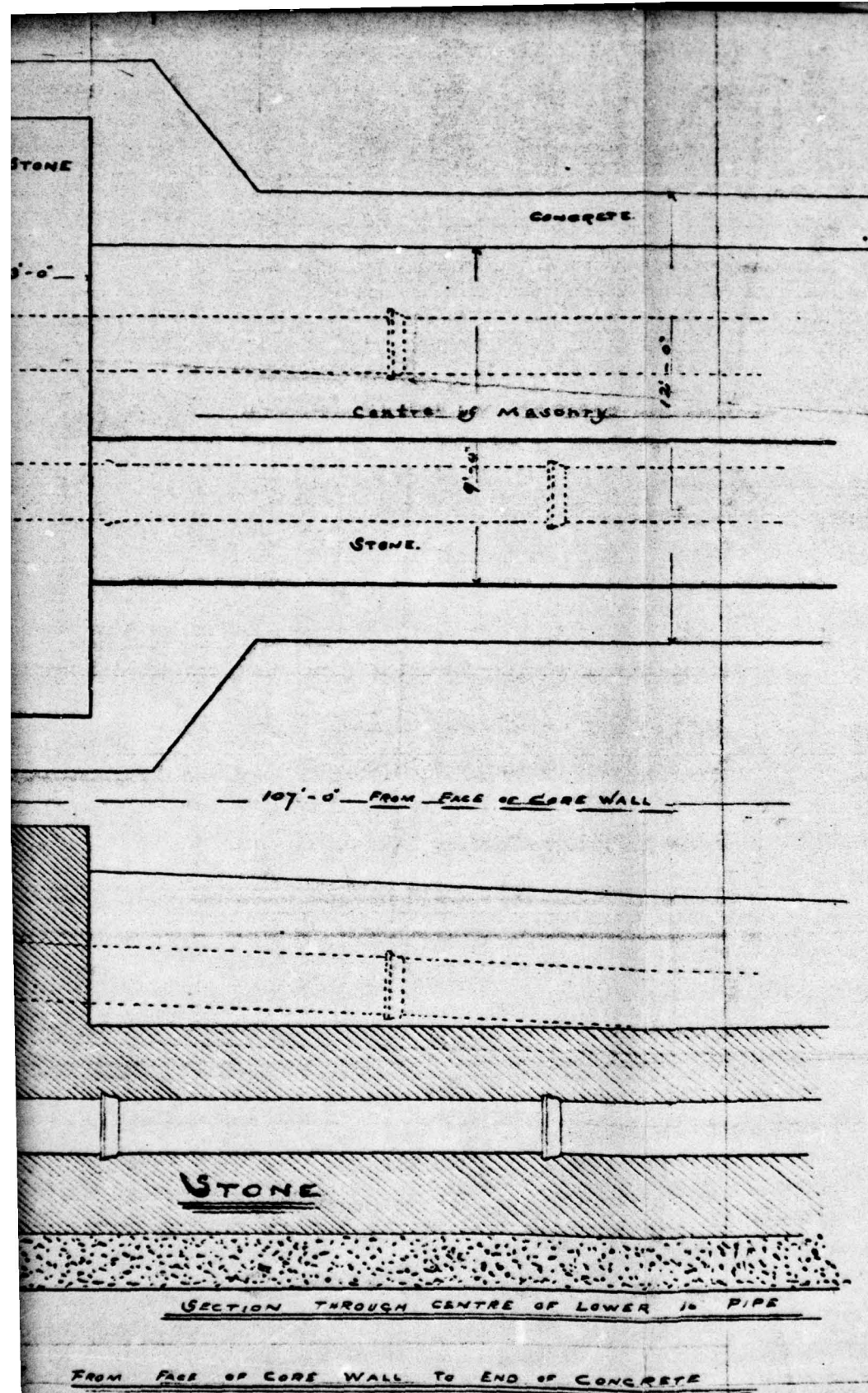
19'-0"



ELEVATION 125"
 RESERVOIR BOTTOM
 AT INNER TEE



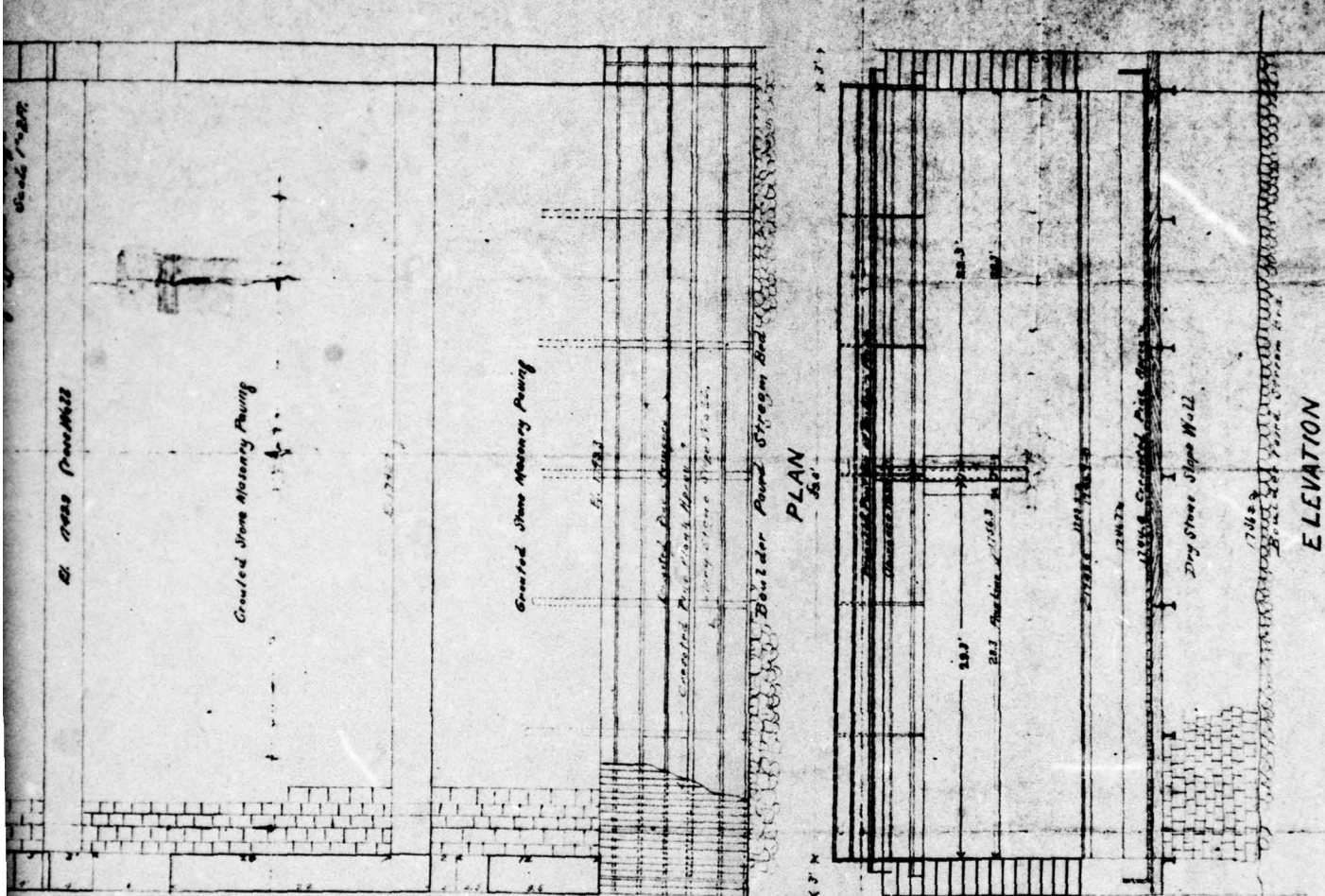
127'-6" FROM



BRADFORD No. 3.

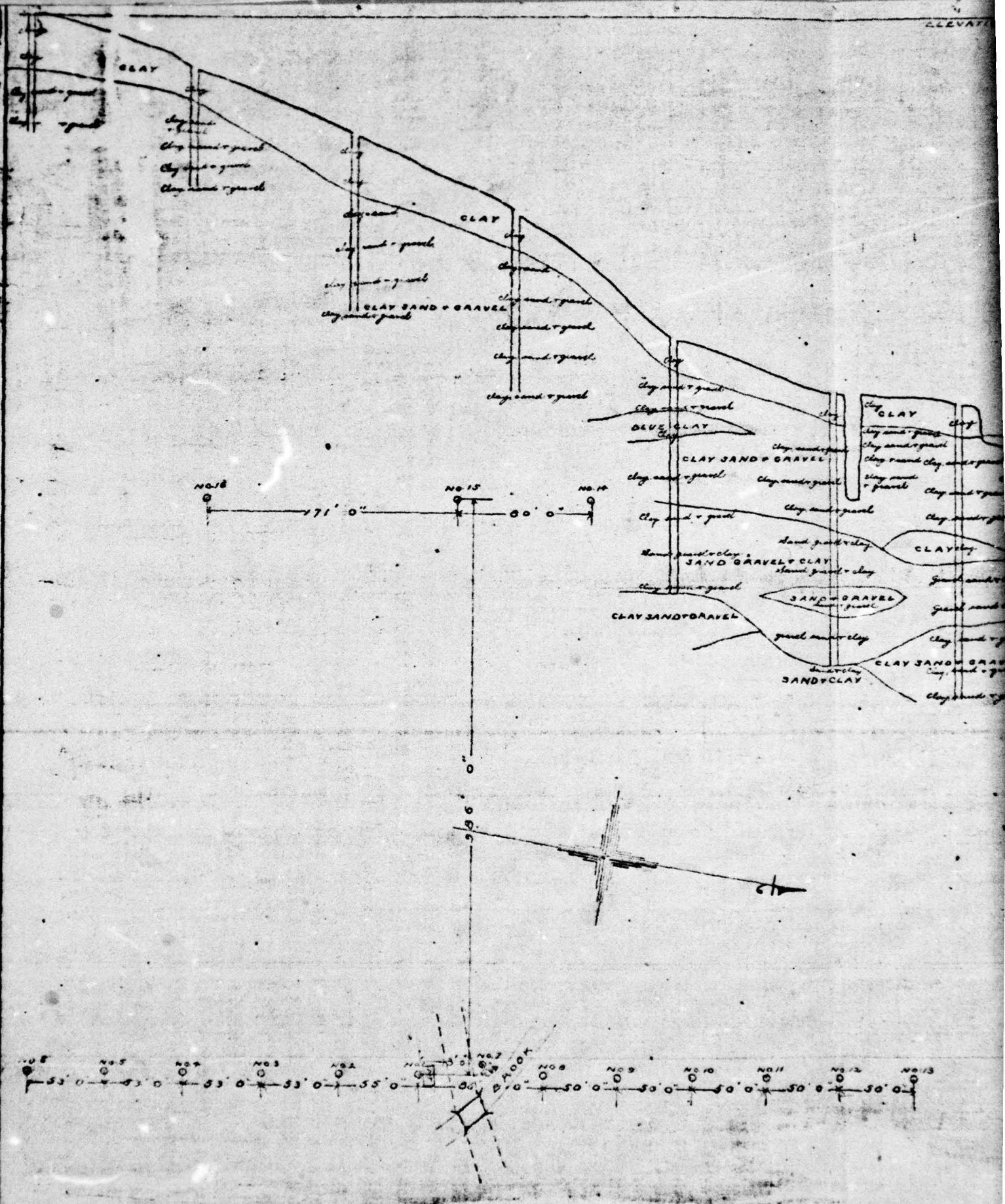
100,000,000 GALLONS.

Detail of Outlet Pipey 1/2 Screen Chamber.

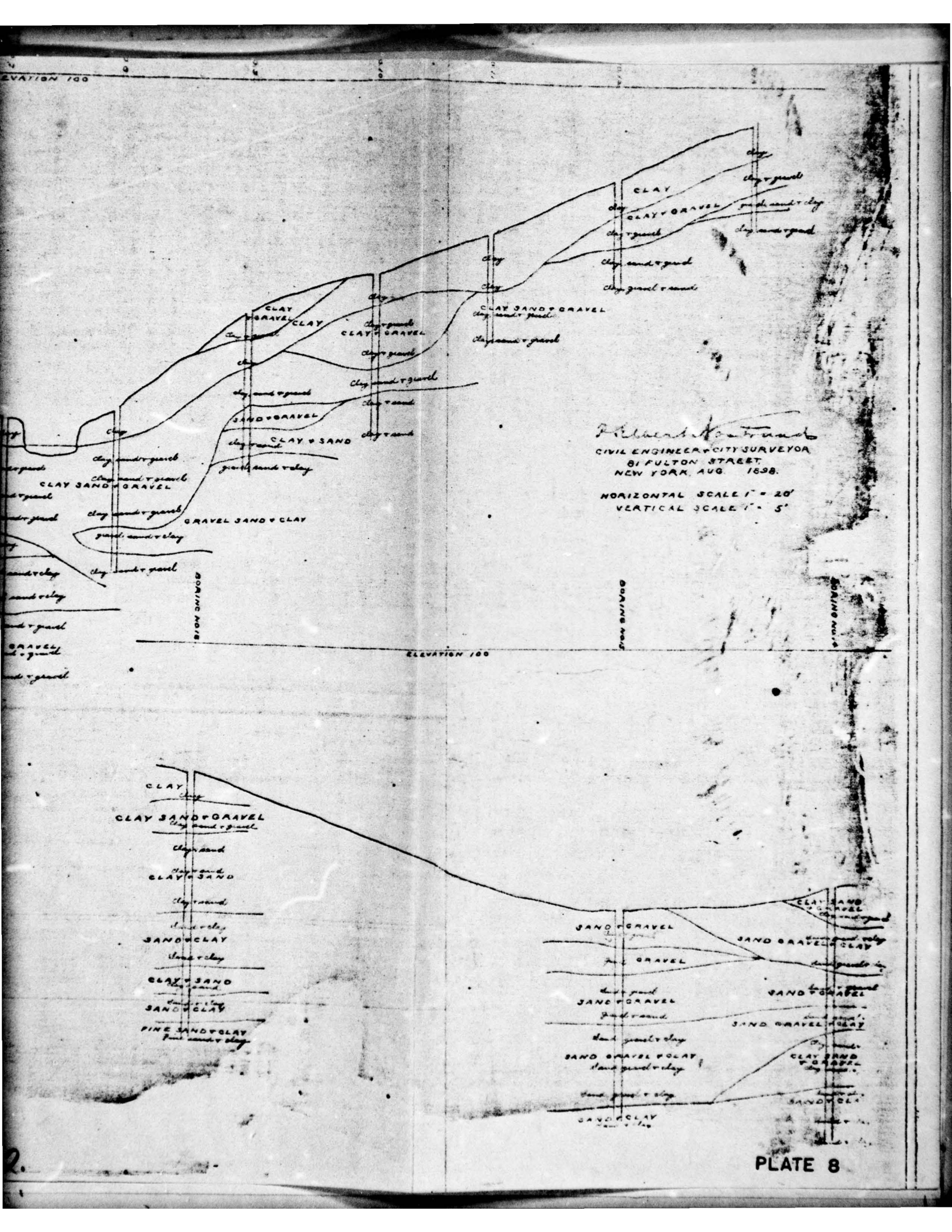
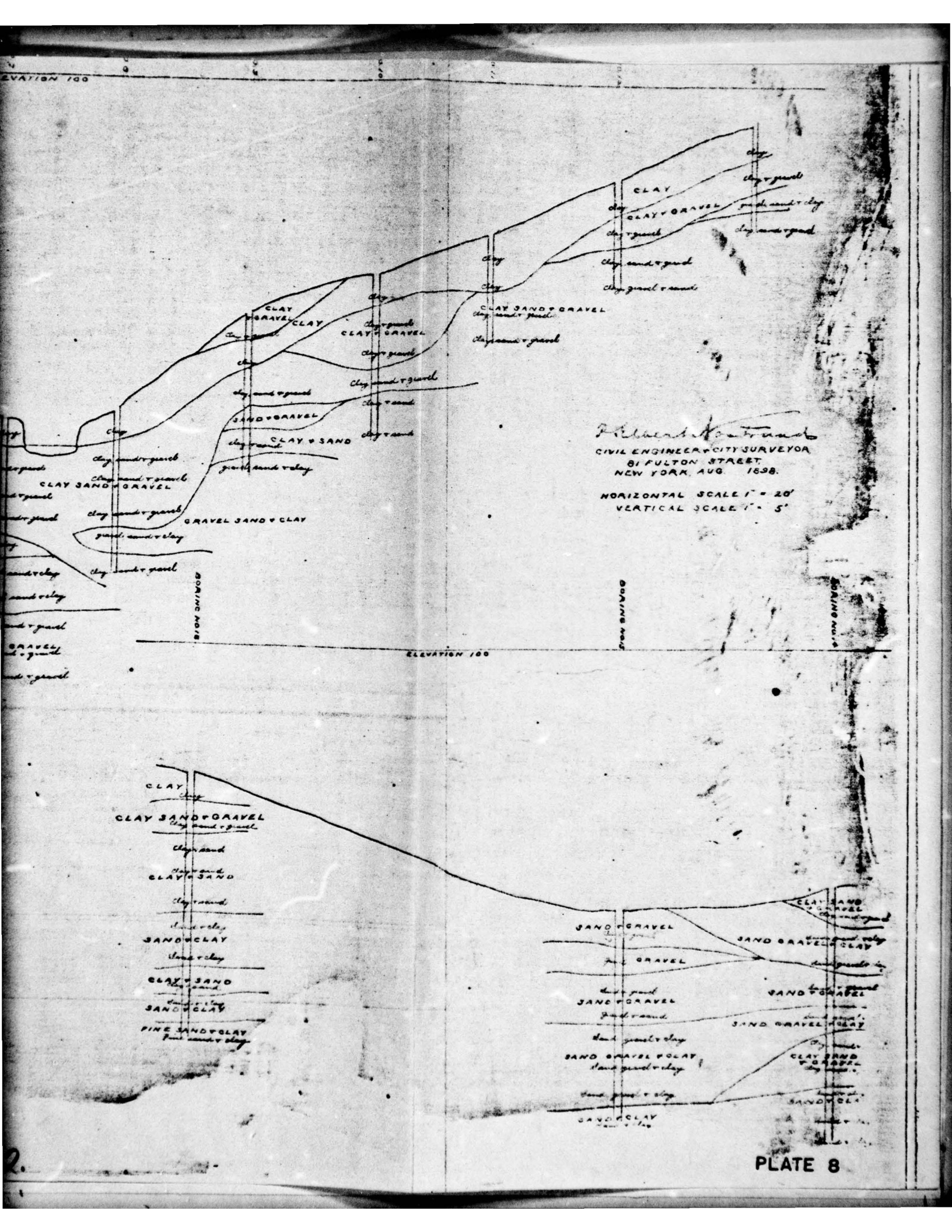


CITY OF BRADFORD, PENNA.
ENGINEERING DEPARTMENT
WASTE WEIR MARILLA RUN RESERVOIR
SHOWING PROPOSED CHANGES IN DAM SECTION & CRIST
INCH - 6 FEET
Sept. 1st. '16
DRAWN 5
Bull-well
GAT. ENGINEER

BRADFORD NO. 3



Chas. A. Mason Aug 1891

[illegible][illegible]

APPENDIX A

**CHECK LIST - VISUAL INSPECTION
AND FIELD SKETCH**

Check List
Visual Inspection
Phase 1

Name of Dam Bradford City No. 3 Dam County McKean State PA Coordinates Lat. N 41° 57.2'
NDI # PA 00025 Long. W 78° 44.4'
Pennder # 42-10

Date(s) Inspection 8 Nov. 1978 Weather Sunny, Clear Temperature 50°F.
and 9 Nov. 1978

NOTE: Approximate Station 0+00 was assumed at the left abutment of the dam.

Pool Elevation at Time of Inspection 1744.0 ft. M.S.L. Tailwater at Time of Inspection 1717.2 ft. M.S.L.
NOTE: The pool elevation was assumed to be El. 1744.0 ft. as indicated on the U.S.G.S. 7.5 minute
topographic quadrangle, Bradford, Pennsylvania. Minor flow (less than 0.1 ft. of water) was
flowing over the spillway crest.

Inspection Personnel:

Michael Baker, Jr., Inc.:

Thomas W. Smith
James G. Ujinski
Rodney E. Holderbaum

Owner's Representatives
(Bradford City Water Authority):

Pat Nuzzo, Superintendent
Dave Haben, Foreman

Rodney E. Holderbaum Recorder

CONCRETE/MASONRY DAMS (N/A)

Name of Dam: BRADFORD CITY NO. 3
 NOI # PA 00025

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS		
DRAINS		
WATER PASSAGES		
FOUNDATION		

LEAKAGE

STRUCTURE TO
 ABUTMENT/EMBANKMENT
 JUNCTIONS

DRAINS

WATER PASSAGES

FOUNDATION

CONCRETE/MASONRY DAMS (N/A)

Name of Dam: BRADFORD CITY NO. 3
DOI # PA 00025

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS		
CONCRETE SURFACES		
STRUCTURAL CRACKING		
VERTICAL AND HORIZONTAL ALIGNMENT		
MONOLITH JOINTS		
CONSTRUCTION JOINTS		

EMBANKMENT

Name of Dam: BRADFORD CITY NO. 3
 NDI # PA 00025

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No surface cracks were observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No unusual movements or cracking was observed at or beyond the toe of the embankment.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing or erosion of the embankment or abutment slopes was observed.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No problems in the horizontal or vertical alignment of the crest were observed.	
RIPRAP FAILURES	No major problem noted. Hand set riprap consisting of sandstone blocks paves the upstream face. "Pop outs" of the sandstone blocks have occurred at several locations on the upstream face approximately 2 ft. below the crest.	The riprap should be restored to its original condition.

EMBANKMENT

Name of Dam: BRADFORD CITY NO. 3
 NDI # PA 00025

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RODENT/ANIMAL BURROWS	Several rodent/animal burrows were observed. The approximate locations of these holes are shown on the field sketch.	These burrows should be repaired. A groundhog/rodent/animal control program should be implemented.

**JUNCTION OF EMBANKMENT
AND ABUTMENT, SPILLWAY
AND DAM**

No problems were observed.

ANY NOTICEABLE SEEPAGE

Yes, minor seepage exists approximately 575 ft. from the left abutment at the toe of the slope. No evidence of piping was observed. Volume of flow estimated at less than 1 g.p.d. Another seepage area exists at approximate Station 3 + 50 at the toe of the slope. This area did not have any discernible flow, but it appeared to be moist all the time.

The seepage areas noted were not piping fine materials at the time of inspection. These seepage areas were noted in previous inspections performed by engineers from PennDER. The volume of flow is not sufficient to warrant installation of a seepage weir. These seepage areas are not considered detrimental to the present stability of the dam, but they should be examined as a part of future periodic inspections.

**STAFF GAGE AND
RECORDER**

None have been installed.

DRAINS

No drains are noted on the plans or were observed during the inspection.

OUTLET WORKS

Name of Dam: BRADFORD CITY NO. 3
NDI # PA 00025

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet conduit is 16-in. cast-iron; no excessive pitting or corrosion was observed.	
INTAKE STRUCTURE	Not accessible, submerged by reservoir.	
OUTLET STRUCTURE	The outlet head wall consists of sandstone blocks. No problems were observed.	
OUTLET CHANNEL	No excessive debris or vegetation blocking channel; no noticeable erosion.	
EMERGENCY GATE	Valve is located in the gate house at toe of dam and can be used to drain reservoir.	Owner indicated that pond drain is opened bi-annually to insure proper operation.

UNGATED SPILLWAY

Name of Dam: BRADFORD CITY NO. 3
 NDI # PA 00025

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
WEIR	The weir and spillway structure consists of sandstone masonry blocks.	Some of the joints in the masonry wall need repointing.

APPROACH CHANNEL

Approach channel is free of debris and obstruction; no erosion was observed.

DISCHARGE CHANNEL

Some minor debris and vegetation is located in the discharge channel.

Discharge channel should be checked periodically for debris and vegetation. All debris and vegetation presently in the discharge channel should be removed.

BRIDGE AND PIERS

A 3-ft. wide steel walkway is located directly above and parallel to the spillway crest; one bridge pier is located at the center of the spillway crest.

Steel walkway and bridge pier are in good condition.

GATED SPILLWAY (N/A)

Name of Dam: BRADFORD CITY NO. 3
 NDI # PA 00025

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL		

CONCRETE SILL

APPROACH CHANNEL

DISCHARGE CHANNEL

BRIDGE AND PIERS

GATES AND OPERATION
EQUIPMENT

INSTRUMENTATION

Name of Dam: BRADFORD CITY NO. 3

NDI # PA 00025

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
--------------------	--------------	----------------------------

MONUMENTATION/SURVEYS

None

OBSERVATION WELLS

None observed

WEIRS

None observed

PIEZOMETERS

None observed

OTHER

Not applicable

RESERVOIR

Name of Dam: BRADFORD CITY NO. 3

NOI # PA 00025

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

SLOPES

The area surrounding the reservoir is gently to moderately sloping and highly forested. No problems were observed.

SEDIMENTATION

No unusual sedimentation was observed.

DOWNSTREAM CHANNEL

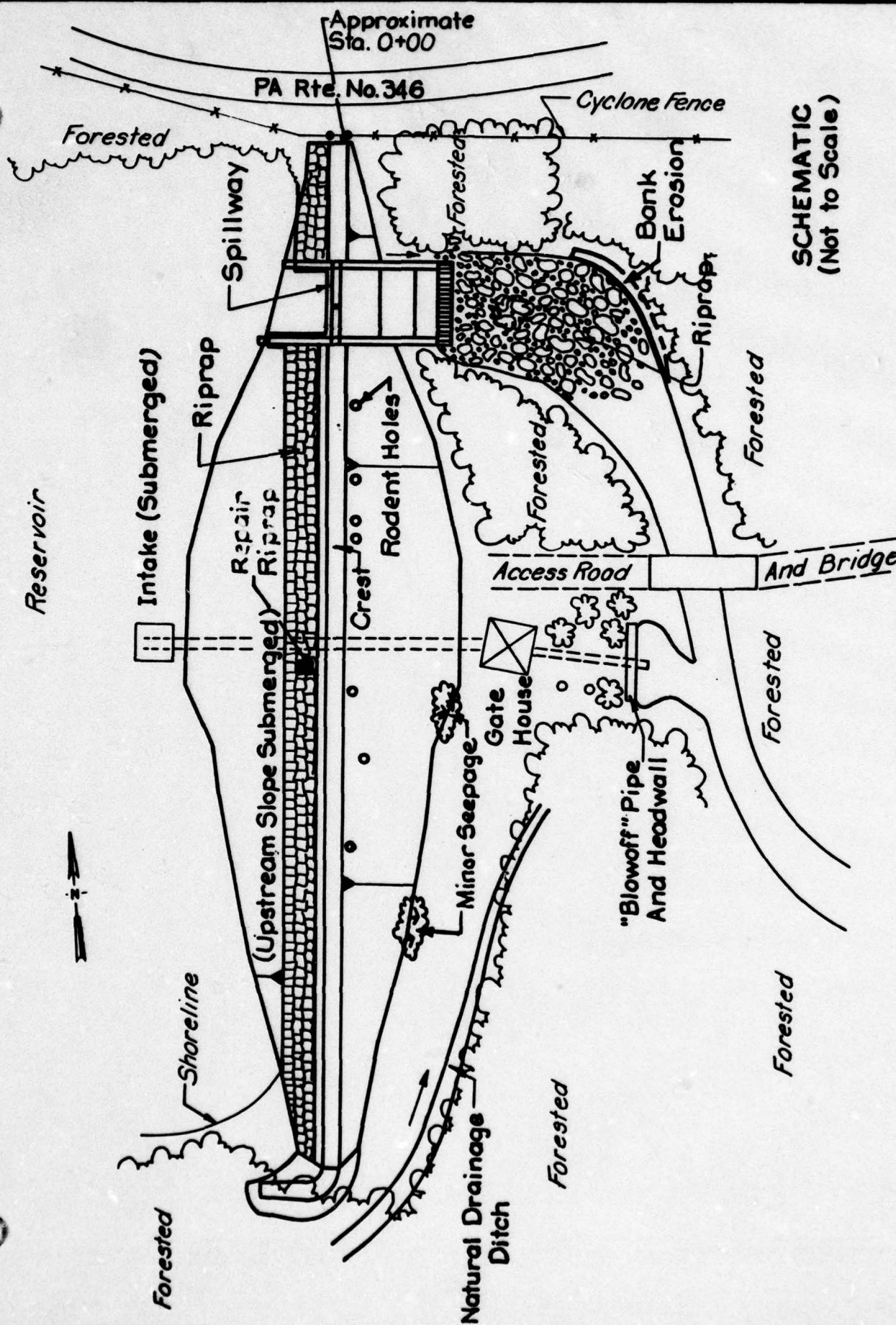
Name of Dam: BRADFORD CITY NO. 3NDI # PA 00025

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Downstream channel is clear of debris and obstructions. A small road bridge is located across the stream, but it is not of the constrictive type.	
--	---	--

SLOPES	The slope of the downstream channel is moderate to steep, averaging approximately 2% gradient.
--------	--

APPROXIMATE NO. OF HOMES AND POPULATION	There are approximately 30 residences located in the first mile downstream of the reservoir. From this point to the City of Bradford (about 3.5 miles downstream), there are several hundred homes. The City of Bradford has a population of nearly 13,000 (1970 census).
---	---



FIELD SKETCH

Bradford City No.3 Dam, Bradford, PA

NDI # PA 00025

APPENDIX B

CHECK LIST - ENGINEERING DATA

**CHECK LIST
ENGINEERING DATA**

Name of Dam: BRADFORD CITY NO. 3 DESIGN, CONSTRUCTION, OPERATION

NDI # PA 00025

ITEM	REMARKS
------	---------

PLAN OF DAM	See Plate 3 of this report.
-------------	-----------------------------

REGIONAL VICINITY MAP	A U.S.G.S. 7.5 Minute Topographic Quadrangle, Bradford, Pennsylvania, was used to prepare the vicinity map which is attached in this report as the Location Plan.
-----------------------	---

CONSTRUCTION HISTORY	The dam was constructed in 1898 under the supervision of Mr. Charles A. Hague, who also prepared the plans. Mr. W. M. Hanley, of Bradford, Pennsylvania, was the contractor. No information concerning the method of construction or changes from the design drawings during construction was available.
----------------------	--

TYPICAL SECTIONS OF DAM	Typical sections of the dam are included as Plates 3 and 4 of this report. Since the dam was designed and constructed in 1898, the details of the drawings may not represent "as built" conditions, however, the general configuration of the dam is as shown on the drawings.
-------------------------	--

HYDROLOGIC/HYDRAULIC DATA	No information available.
---------------------------	---------------------------

OUTLETS - PLAN	See Plates 4 and 6 of this report.
----------------	------------------------------------

- DETAILS	See Plates 4 and 6 of this report.
-----------	------------------------------------

- CONSTRAINTS	The 16-in. pipe is controlled by a valve located at the gate house.
---------------	---

- DISCHARGE RATINGS	No discharge ratings for the outlet pipes were available.
---------------------	---

RAINFALL/RESERVOIR RECORDS	No records are available at the dam site.
----------------------------	---

Name of Dam: BRADFORD CITY NO. 3
 NDI # PA 00025

ITEM	REMARKS
DESIGN REPORTS	No design reports were available.
GEOLOGY REPORTS	No geology reports were available. However, a general description of the geology is presented as Appendix E of this report.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	In 1923, the height of embankment was raised approximately 3 ft. With the raising of embankment, the hydraulic capacity was calculated to be 2200 c.f.s. when 5.7 ft. of water was flowing over the spillway crest (or 1 ft. below the top of embankment). These calculations were performed by the Water Supply Commission of Pennsylvania (predecessor of Pennder) and are present in Pennder's file for this dam. No other design computations are available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	The original soil borings and soil profile is presented as Plate 8 of this report. The record of borings, made under the direction of Elbert Nostrand, Engineer and Surveyor, of New York, New York, was prepared in August 1898 and was attached to the set of original blueprints borrowed from the Bradford City Water Department.
POST-CONSTRUCTION SURVEYS OF DAM	No information concerning post-construction surveys of the dam was available.
BORROW SOURCES	According to information contained in the Pennder correspondence files, material for the earth embankment was taken from the upper end of the reservoir. Other information noting the exact location is not available.

Name of Dam: BRADFORD CITY NO. 3
 NDI # PA 00025

ITEM	REMARKS
------	---------

MONITORING SYSTEMS	No monitoring systems have been provided.
--------------------	---

MODIFICATIONS In 1923, the embankment was raised 3 ft. by T. J. Callahan, Contractor, to increase the hydraulic capacity of the spillway before overtopping would occur. At the same time, the spillway approach channel was repaved with 12 in. of reinforced concrete.

HIGH POOL RECORDS No detailed records are available.

POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS In 1915, the Water Supply Commission of Pennsylvania made an inspection and short report of the dam. Since the 1915 inspection, the dam has been inspected an additional 18 times. These inspection reports are available in the Penndel file for this dam.

PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS No prior accidents or failure of the dam have been noted.

MAINTENANCE OPERATION RECORDS No maintenance or operation records are available.

Name of Dam: BRADFORD CITY NO. 3

NDI # PA 00025

ITEM

REMARKS

SPILLWAY PLAN

See Plates 5 and 7 of this report.

SECTIONS

DETAILS

OPERATING EQUIPMENT
PLANS & DETAILS

See Plate 5 of this report. This is an original design drawing and may not represent the "as built" condition. Subsequent to the construction of the dam, a pump house was constructed over the downstream valve chamber. It is not known what modifications were performed at that time.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 4.8 sq.mi. (forested)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1744.0 ft. (368 ac.-ft.)

ELEVATION AVERAGE TOP OF DAM (STORAGE CAPACITY): 1750.8 ft. (502 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1750.8 ft. (average elevation), 1750.4 ft. (minimum elevation)

CREST: Principal Spillway

- a. Elevation 1744.0 ft.
- b. Type Overflow spillway through embankment of dam
- c. Width 58.6 ft.
- d. Length 89 ft. from crest to downstream end of spillway
- e. Location Spillover Approximately 90 ft. from left abutment of dam
- f. Number and Type of Gates None

OUTLET WORKS: Pipe Outlet

- a. Type 16-in. cast-iron pipe
- b. Location Approximate center of dam
- c. Entrance inverts Unknown
- d. Exit inverts 1716.3 ft.
- e. Emergency draindown facilities Gated 16-in. C.I.P.

HYDROMETEOROLOGICAL GAGES: None

- a. Type _____
- b. Location _____
- c. Records _____

MAXIMUM NON-DAMAGING DISCHARGE Not available

APPENDIX C

PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam

- Upstream - View From Left Abutment Looking South Along
Upstream Crest of the Dam - 8 November 1978
(Spillway walls and bridge in center of photo.)
- Downstream - View From Left Side of Spillway Looking South
Along Downstream Slope of the Embankment -
8 November 1978

Photo 1: View of Upstream Portion of the Spillway -
8 November 1978

Photo 2: View of Downstream Portion of the Spillway -
9 November 1978

Photo 3: View of Outlet Pipe and Outlet Pipe Head Wall -
9 November 1978

Photo 4: View Looking Upstream at the Bridge Across the
Downstream Channel - 9 November 1978

BRADFORD CITY No. 3 DAM



PHOTO 1. View of Upstream Portion of Spillway

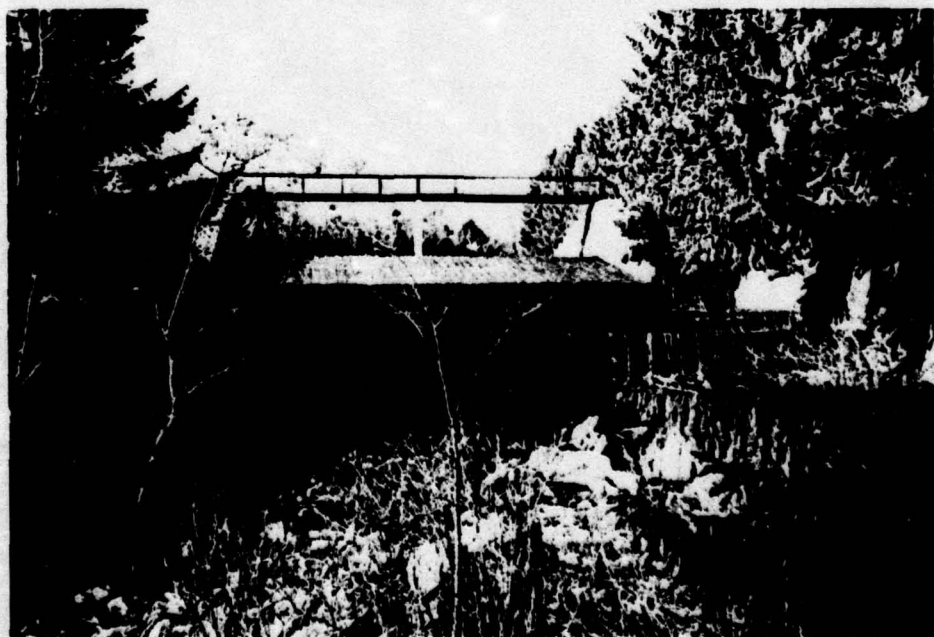


PHOTO 2. View of Downstream Portion of Spillway

BRADFORD CITY No. 3 DAM

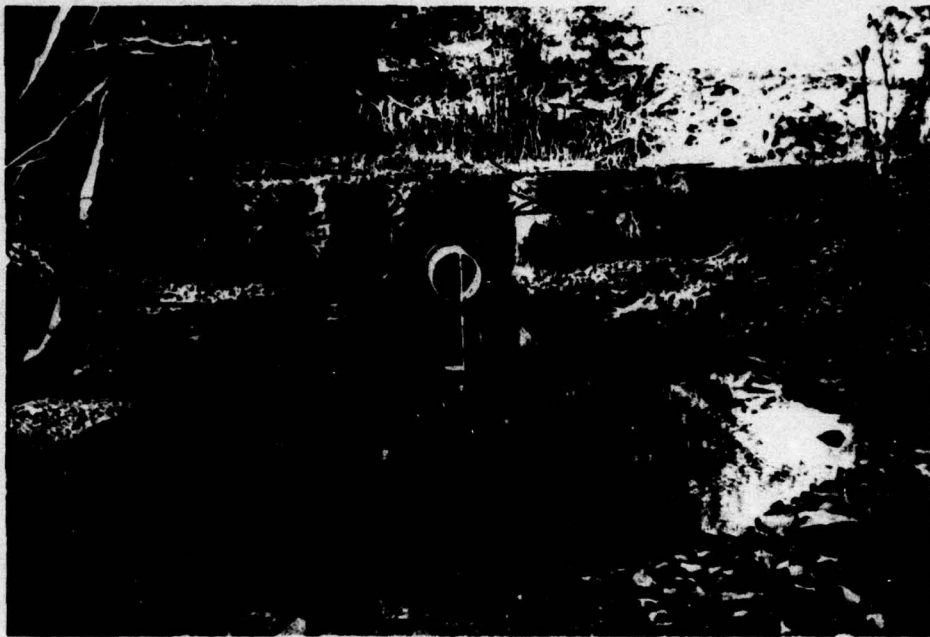


PHOTO 3. View of Outlet Pipe and Outlet Pipe Head Wall



PHOTO 4. View Looking Upstream at Bridge Across Downstream Channel

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bradford No. 3

S.O. No. _____

Sheet No. _____ of _____

Drawing No. _____

Computed by _____

Checked by _____

Date _____

Table of Contents

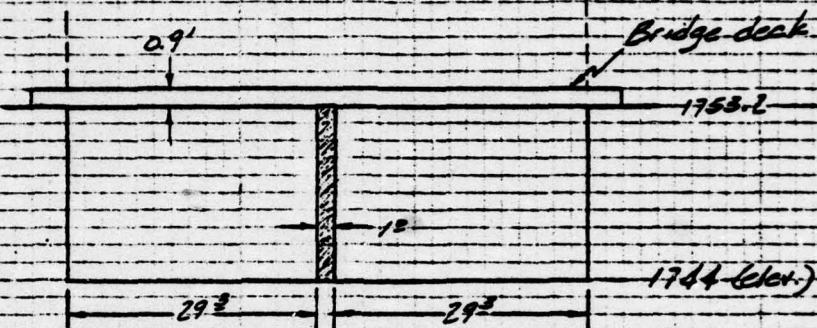
Spillway Rating	1-2
Top of Dam Profile	3
Hydrology (Snyders)	4
PMP, Storage, Overlapping Data	5
Damage Area Map	6
Flood Routings	7-12

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject PA Dam Inspections
Bradford City No. 3
Spillway Rating
Computed by REH Checked by _____

S.O. No. _____
Sheet No. 1 of 12
Drawing No. _____
Date 12-8-78



Q (cfs)	q (cfs/ft)	d_c (ft)	A (ft ²)	V (ft/s)	$V^2/2g$	H_d	H_{SEI} (ft.)
100	1.71	0.45	26.30	3.80	0.22	0.67	44.67
400	6.83	1.13	66.28	6.03	0.57	1.70	45.70
500	13.65	1.80	105.21	7.60	0.90	2.70	46.70
1200	20.48	2.35	137.87	8.70	1.18	3.53	47.53
1600	27.30	2.85	167.02	9.58	1.43	4.28	48.28
2000	34.13	3.31	193.80	10.32	1.65	4.96	48.96
2500	42.66	3.84	224.89	11.12	1.92	5.76	49.76
3000	51.19	4.33	253.95	11.81	2.17	6.50	50.50
3500	59.73	4.80	281.44	12.44	2.40	7.20	51.20
4000	68.26	5.24	307.14	13.02	2.63	7.87	51.87
4500	76.79	5.68	332.72	13.52	2.84	8.52	52.52
5000	85.32	6.09	356.99	14.01	3.05	9.14	53.14
6000	102.39	6.88					

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject PA Dam Inspections
Bradford City No. 3
Spillway Rating
Computed by REN

S.O. No. _____
Sheet No. 2 of 12
Drawing No. _____
Date 12-11-78

Where:

$$Q = Q/38.6$$

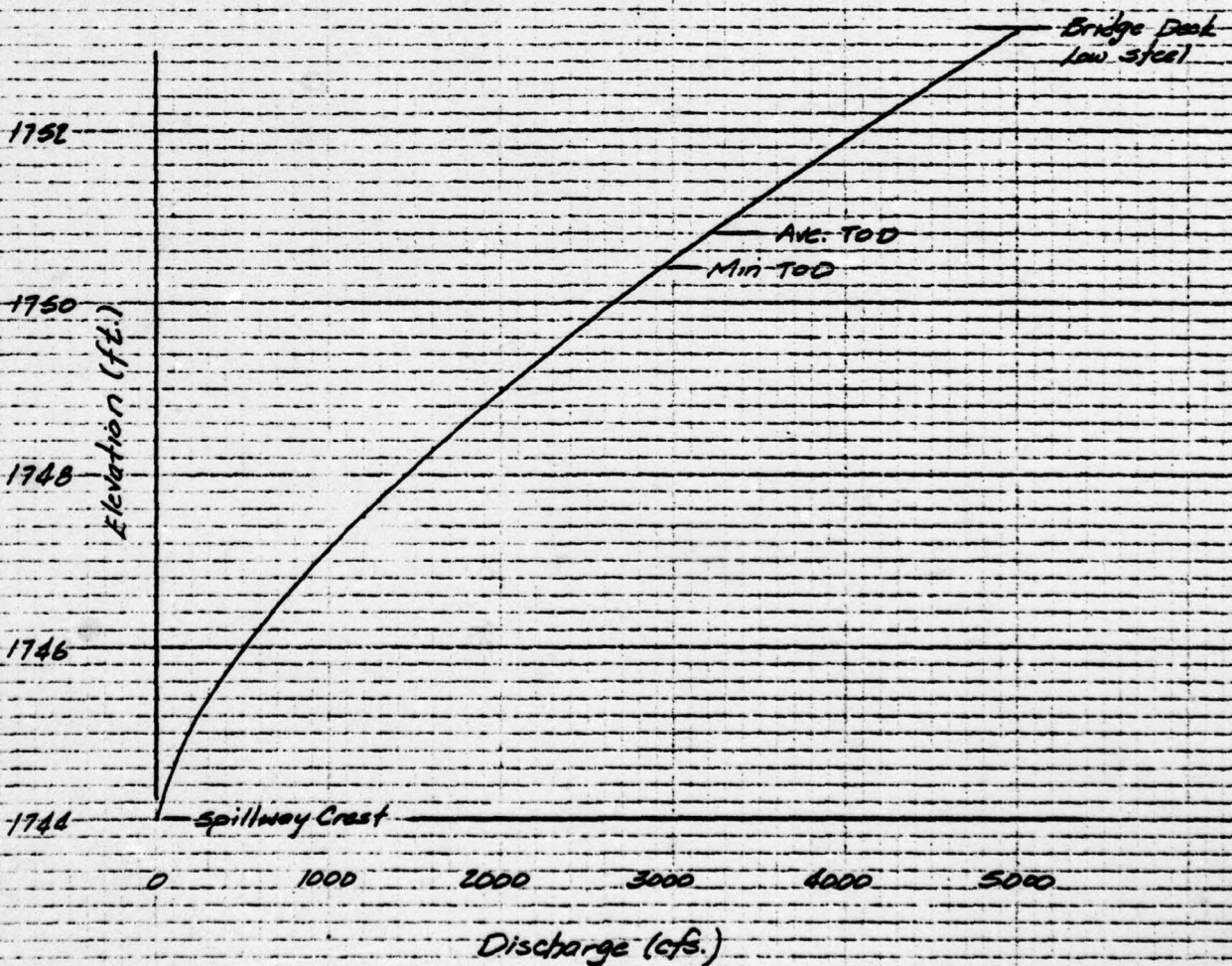
$$A = d_c (38.6)$$

$$EG = d_c + V^2/2g$$

$$d_c = \sqrt[3]{Q^2/g}$$

$$V = Q/A$$

$$HSEL = 1744 + EG$$



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject PA Dam Inspections
Bradford No. 3
TOD Profile

Computed by REH

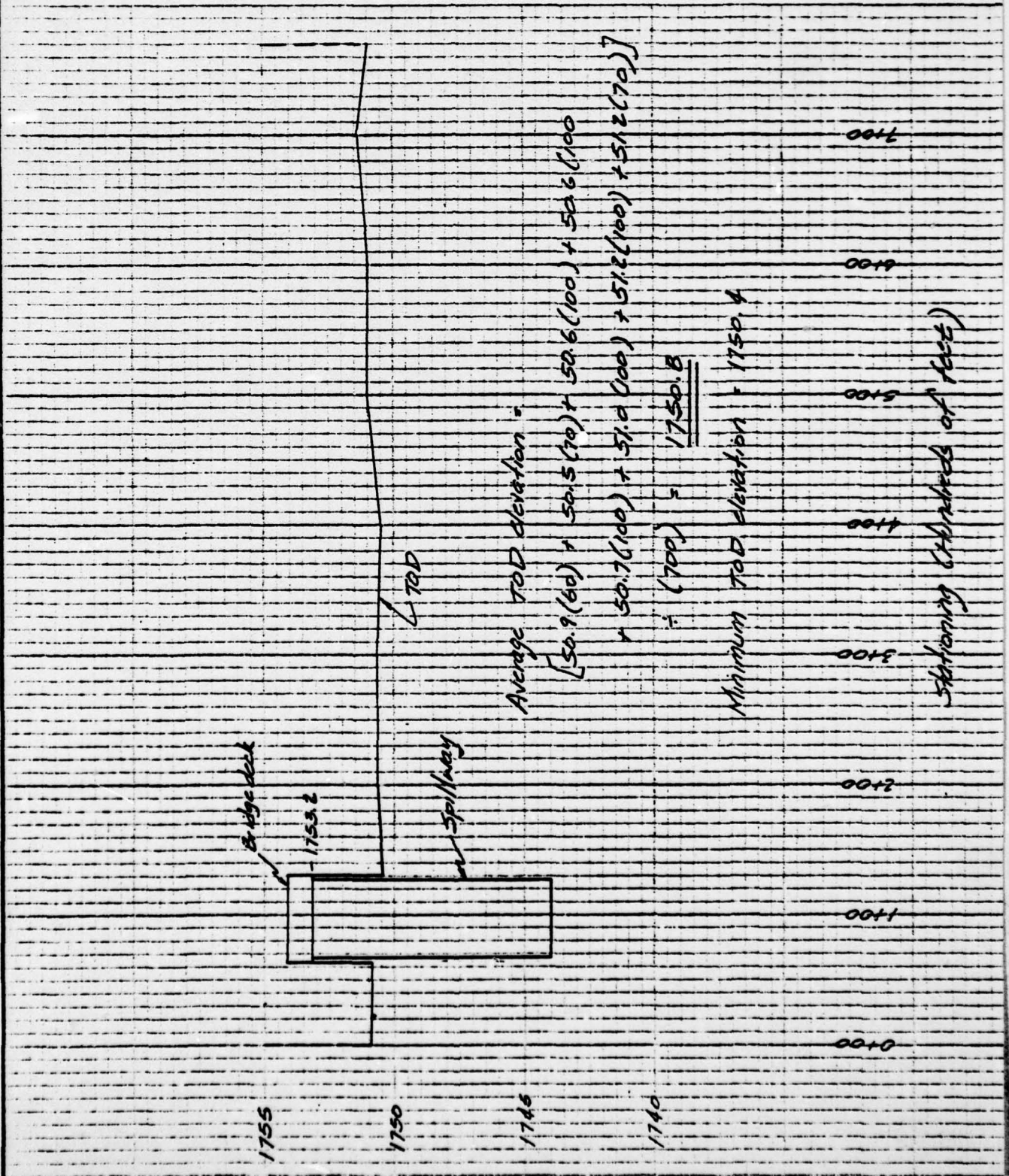
Checked by _____

S.O. No. _____

Sheet No. 3 of 12

Drawing No. _____

Date 12/8/78



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bradford No. 3 Dam

Hydrology - Snyder's Method

S.O. No. _____

Sheet No. 4 of 12

Drawing No. _____

Computed by DJG

Checked by _____

Date _____

Area 1.3 $\Rightarrow C_p = 0.55$, use plot L for C_p

Sub-basin A

$$t_p = 3.3(K_{LCA})^{0.3}$$

$$t_p = 3.3 \left[\left(\frac{13000}{5180} \right) \left(\frac{6320}{5180} \right) \right]^{0.3} = 4.57 \text{ hours}$$

adjustment to 30 min. duration.

$$t_p = 4.57 + 0.25 \left(0.5 - \frac{4.57}{6.5} \right) = 4.89 \text{ hours}$$

Sub-basin B

$$t_p = 3.3(K_{LCA})^{0.3}$$

$$t_p = 3.3 \left[\left(\frac{11900}{5180} \right) \left(\frac{8080}{5180} \right) \right]^{0.3} = 5.41 \text{ hours}$$

adjustment to 30 min. duration:

$$t_p = 5.41 + 0.25 \left(0.5 - \frac{5.41}{6.5} \right) = 5.19 \text{ hours}$$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bradford Number 3 S.O. No. _____
PMP, storage, overtopping Sheet No. 5 of 12
Data Drawing No. _____
Computed by REH Checked by _____ Date 1-7-79

PMP Estimate (from HMR-33)

PMP = 22.5 inches

Zone 2 Ratios

6 hr.	111%
12 hr.	121%
24 hr.	141%
48 hr.	151%

Reservoir Storage

Normal Pool 120 mg. = 362.3 A-F (From DER file)

$$\Delta E = \frac{33}{\text{Area}} = \frac{3(362)}{18.18} = 60.73 \text{ ft.} \quad E_{10} = 1144.60.7 = 1623.3 \text{ ft.}$$

$$\text{Elev } 1146.0 \quad \text{Area} = 230.18 \text{ in.}^2 \left(\frac{60^2}{17^2} \right) \frac{1 \text{ Ac.}}{43560 \text{ ft.}^2} = 19.02 \text{ Ac.}$$

Overtopping Rating

Average Top of Dam Elev. = 1150.8 feet

Dam length to Elev 1153.2 = 640 + 62 = 702 ft.

Width of Crest = 12 ft. (Weir coeff.) = 2.64

from: Handbook of Hydraulics

King & Brater pg. 5-46



FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 25 SEP 78

RUN DATE 02/13/79
TIME 08.35

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF BRADFORD CITY NO. 3 M6J 19
PROBABLE MAXIMUM FLOOD PHE/UNIT GRAPH BY SNYDER'S METHOD

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	JHR	IMIN	METG	IPAT	IPRT	INSTAN
250	0	30	0	0	0	0	0	-4	0
			JOPER	NMT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 4 LRTIO= 1

RTIOS= 1.00 0.50 0.40 0.30

SUB-AREA RUNOFF COMPUTATION

THIS IS THE INFLOW HYDROGRAPH TO DAM NO. 3 FROM SOUTHWEST TRIBUTARY

1STAQ	ICOMP	ISECON	ITAPE	JPLT	JMRT	INAME	ISTAGE	IAUTO
TR18-8	0	0	0	0	0	0	0	0

HYDROGRAPH DATA

INVOG	1	LUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISANE	LOCAL
		1	3.19	0.0	4.83	0.0	0.0	0	0	0

PRECIP DATA

SFFF	PMS	R6	R12	R24	R48	R72	R96
0.0	22.80	117.00	127.00	141.00	151.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.000

LOSS DATA

LROPT	STARR	DLTKR	RTIOL	ERAIN	STKRS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.05	0.0	0.0

UNIT HYDROGRAPH DATA

TP= 5.29 CP=0.55 NTA= 0

RECESSION DATA

STRTO= -1.50 ORCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 73 END-OF-PERIOD ORIGINATES, LAG= 5.28 HOURS, CP= 0.55 VOL= 1.00

6.	22.	44.	71.	100.	131.	160.	184.	202.	214.
218.	211.	197.	182.	168.	155.	143.	132.	122.	112.
104.	96.	88.	81.	75.	69.	64.	59.	54.	50.
46.	43.	40.	36.	34.	31.	29.	26.	24.	23.
21.	19.	18.	16.	15.	14.	13.	12.	11.	10.

9. 4. 2. 8. 4. 2. 7. 3. 6. 3. 6. 3. 5. 2. 5. 2.

0 MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q NO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q
END-OF-PERIOD FLOW
SUM 27.54 25.11 2.43 103810.
(700.11 638.11 62.11 2939.588)

SUB-AREA RUNOFF COMPUTATION

THIS IS THE INFLOW HYDROGRAPH TO DAM NO.3 FROM THE NORTHWEST TRIBUTARY

ISTAQ ICOMP IECON ITAPE JPLT JPRY INAME ISTAGE IAUTO
TRIB-A 0 0 0 0 0 0 0 0 0

HYDROGRAPH DATA

1 IHYDG JUNG TAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LOCAL
1 1 1.64 0.0 4.83 0.0 0.0 0 0 0

PRECIP DATA

SPFE PMS R6 R12 R24 R48 R72 R96
0.0 22.80 117.00 127.00 141.00 151.00 0.0 0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

1 RDOPT STAKR DLTGR RIJOL ERJIN STAKS ATIOK STIRL CHSIL ALSNK RTIMP
0 0.0 0.0 0.0 1.00 0.0 0.0 1.00 1.00 0.05 0.0 0.0

UNIT HYDROGRAPH DATA

TP= 4.49 CP=0.55 NTA= 0

RECESSION DATA

STATQ= -1.50 ORCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 61 END-OF-PERIOD ORIGINATES, LAG= 4.52 HOURS, CP= 0.55 VOL= 1.00

| | | | | | | | | | |
|------|------|------|-----|-----|-----|------|------|------|------|
| 4. | 17. | 34. | 54. | 76. | 97. | 114. | 126. | 132. | 130. |
| 121. | 110. | 100. | 91. | 83. | 75. | 68. | 62. | 57. | 51. |
| 47. | 42. | 39. | 35. | 32. | 29. | 26. | 24. | 22. | 20. |
| 18. | 16. | 15. | 13. | 12. | 11. | 10. | 9. | 8. | 8. |
| 7. | 6. | 6. | 5. | 5. | 4. | 4. | 4. | 3. | 3. |
| 3. | 2. | 2. | 2. | 2. | 2. | 2. | 1. | 1. | 1. |

END-OF-PERIOD FLOW

0 MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q NO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q
SUM 27.54 25.11 2.43 53637.
(700.11 638.11 62.11 1518.838)

COMBINE HYDROGRAPHS

COMBINE THE TWO TRIBUTARIES FOR ROUTING THROUGH THE DAM

ISTAQ ICOMP IECON ITAPE JPLT JPRY INAME ISTAGE IAUTO

9 of 12

LAKE 2 0 0 0 0 0 0 0 0 0

HYDROGRAPH ROUTING

THIS IS THE ROUTING OF THE COMBINED FLOWS MIN TDD=1750.4 AVG TDD=1750.8

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO
SPWY 0 0 0 0 0 0 0 0

ROUTING DATA
QLOSS CROSS AVG IRES ISAME IOPT IPMP LSTA
0.0 0.0 0.0 1 1 0 0 0

NSTPS NSTDL LAG ANSKK X TSK STORA ISPRAT
1 0 0 0.0 0.0 0.0 -1744. -1

STAGE 1744.00 1744.67 1745.70 1746.70 1747.53 1748.28 1748.96 1749.76 1750.50 1751.20
1751.90 1752.52 1753.14

FLOW 0.0 100.00 400.00 800.00 1200.00 1600.00 2000.00 2500.00 3000.00 3500.00
4000.00 4500.00 5000.00

SURFACE AREA= 0. 18. 19. 27.
CAPACITY= 0. 368. 405. 723.

ELEVATION= 1683. 1744. 1746. 1760.
CREL SPWID COOH EXPH ELEV COOL CAREA EXPL
1744.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DAM DATA
TOPEL COOD EXPD DAMWID
1750.8 2.6 1.5 702.

PEAK OUTFLOW IS 6645. AT TIME 44.50 HOURS

PEAK OUTFLOW IS 3306. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 2640. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 1977. AT TIME 45.00 HOURS

10 of 12

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

| OPERATION | STATION | AREA | PLAN | RATIO 1 | RATIO 2 | RATIO 3 | RATIO 4 |
|----------------------|---------|--------|------|----------|---------|---------|---------|
| | | | | 1.00 | 0.50 | 0.40 | 0.30 |
| HYDROGRAPH AT TRIB-B | | | | | | | |
| | | 3.19 | 1 | 5226 | 2113 | 1631 | 1268 |
| | (| 0.261 | (| 119.6811 | 59.8411 | 47.0711 | 35.9011 |
| HYDROGRAPH AT TRIB-A | | | | | | | |
| | | 1.64 | 1 | 2466 | 1233 | 987 | 740 |
| | (| 4.251 | (| 69.8411 | 34.9211 | 27.9311 | 20.9511 |
| 2 COMBINED LAKE | | | | | | | |
| | | 5.83 | 1 | 6653 | 3326 | 2661 | 1996 |
| | (| 12.511 | (| 188.3911 | 94.1911 | 75.3511 | 56.5211 |
| ROUTED TO SPV | | | | | | | |
| | | 5.83 | 1 | 6645 | 3306 | 2640 | 1977 |
| | (| 12.511 | (| 188.1711 | 93.6211 | 74.7511 | 56.0011 |

E

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APPENDIX E

REGIONAL GEOLOGY

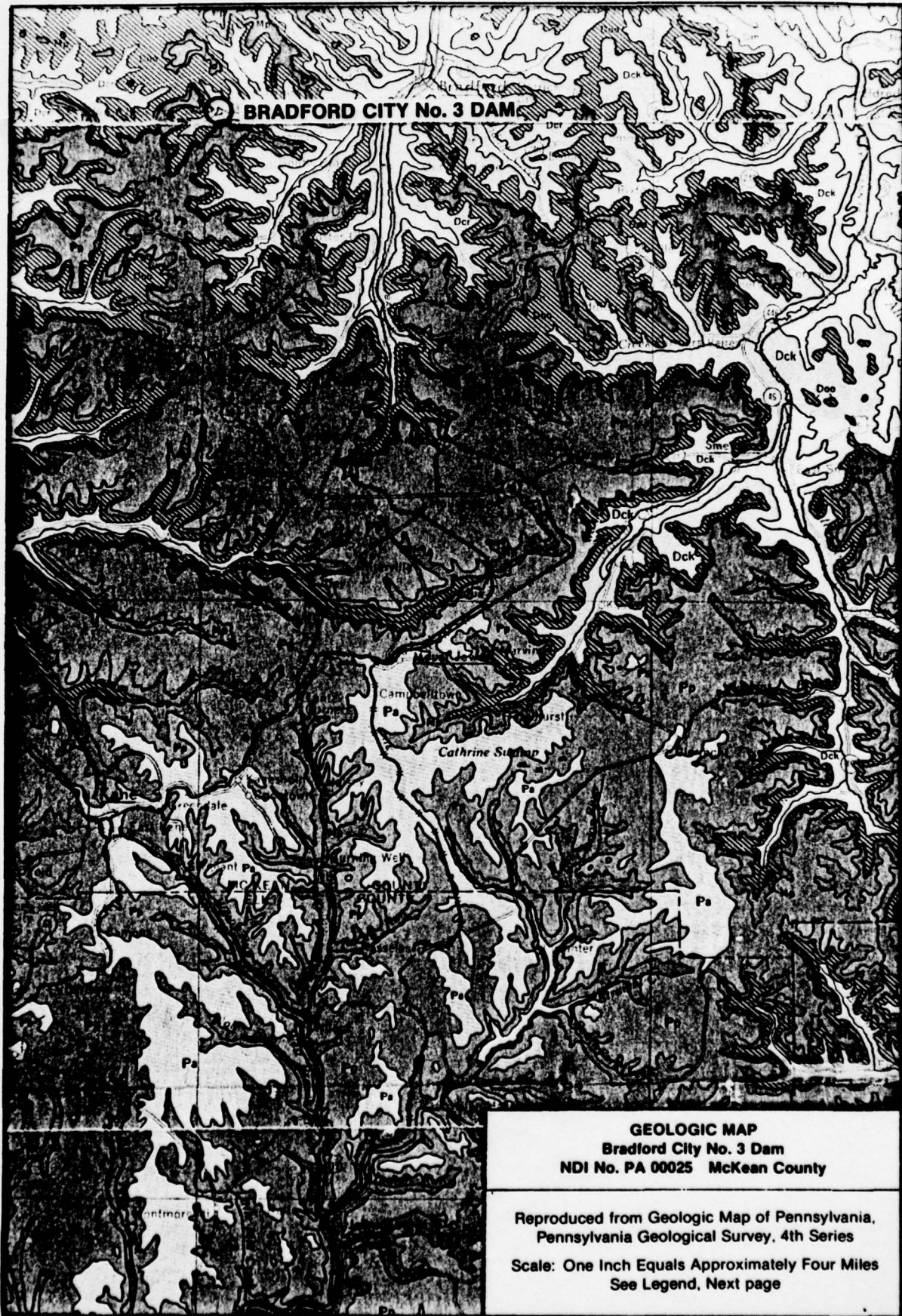
BRADFORD CITY NO. 3 DAM
NDI NO. PA 00025, PennDER No. 42-10

REGIONAL GEOLOGY

Bradford City No. 3 Dam is located in the unglaciated section of the northern portion of the Appalachian Plateaus physiographic province. Bedrock units are members of the Cattaraugus formation of the Upper Devonian system which are typically red, gray and brown sandstones and shales. These strata are essentially horizontal with gentle regional folding. References do not indicate any faulting in the vicinity of the dam.

Although the area has not been glaciated, the dam is located a short distance upstream from the relatively thick glacial stream and lake deposits which fill the valleys of Tunungwant (Tuna) Creek and its tributaries. However, it appears that most the dam and reservoir are located on residual soils of the Allegheny-Dekalb soil group which reportedly average about 4 feet in thickness. A small amount of alluvium may be present.

NEW YORK BORDER



LEGEND

PERMIAN



Greene Formation

Cyclic sequences of sandstone, shale, red beds, limestone and coal; base at the top of the Upper Washington Limestone.

PERMIAN AND PENNSYLVANIAN



Washington Formation

Cyclic sequences of sandstone, shale, limestone and coal; some red shale; some mineable coal; base at the top of the Wayneburg Coal.

PENNSYLVANIAN

APPALACHIAN PLATEAU



Monongahela Formation

Cyclic sequences of sandstone, shale, limestone and coal; limestone prominent in northern outcrop areas; shale and sandstone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal.



Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of section; Brush Creek Limestone in lower part of section.



Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestones thicken westward; Vanport Limestone in lower part of section; includes P'seport, Kuananing, and Clarion Formations.



Pottsville Group

Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.

ANTHRACITE REGION



Post-Pottsville Formations

Brown or gray sandstones and shales with some conglomerate and numerous mineable coals.



Pottsville Group

Light gray to white, coarse grained sandstones and conglomerates with some mineable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

MISSISSIPPIAN



Mauch Chunk Formation

Red shales with brown to greenish gray fluggy sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties; Loganassa Limestone at the base in southwestern Pennsylvania.



Pocono Group

Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Cussewago, Carry, and Knapp Formations; includes part of "Onaway" of M. L. Fuller in Potter and Tioga counties.

DEVONIAN UPPER

WESTERN PENNSYLVANIA



Onaway Formation

Greenish gray to gray shales, siltstones and sandstones becoming increasingly shaly westward; considered equivalent to type Onaway, Riceville Formation Or in Erie and Crawford Counties; probably not distinguishable north of Carry.



Cattaraugus Formation

Red, gray and brown shale and sandstone with the proportion of red decreasing westward; includes Venango sands of drillers and Salamanca sandstone and conglomerate; some limestone in Crawford and Erie counties.



Conneaut Group

Alternating gray, brown, greenish and purplish shales and siltstones; includes "pink rock" of drillers and "Chermung" and "Girard" Formations of northwestern Pennsylvania.



Canadaway Formation

Alternating brown shales and sandstones; includes "Portage" Formation of northwestern Pennsylvania.